

TREATISE ON
VENTILATORS
HALES

JONAS GREEN COPY

LONDON, 1758





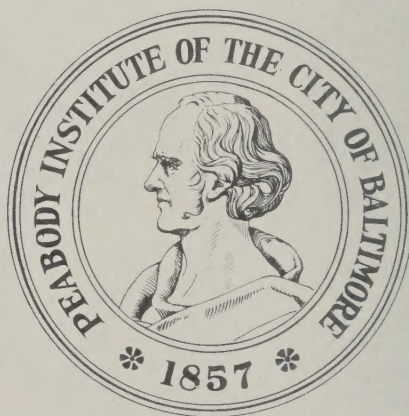


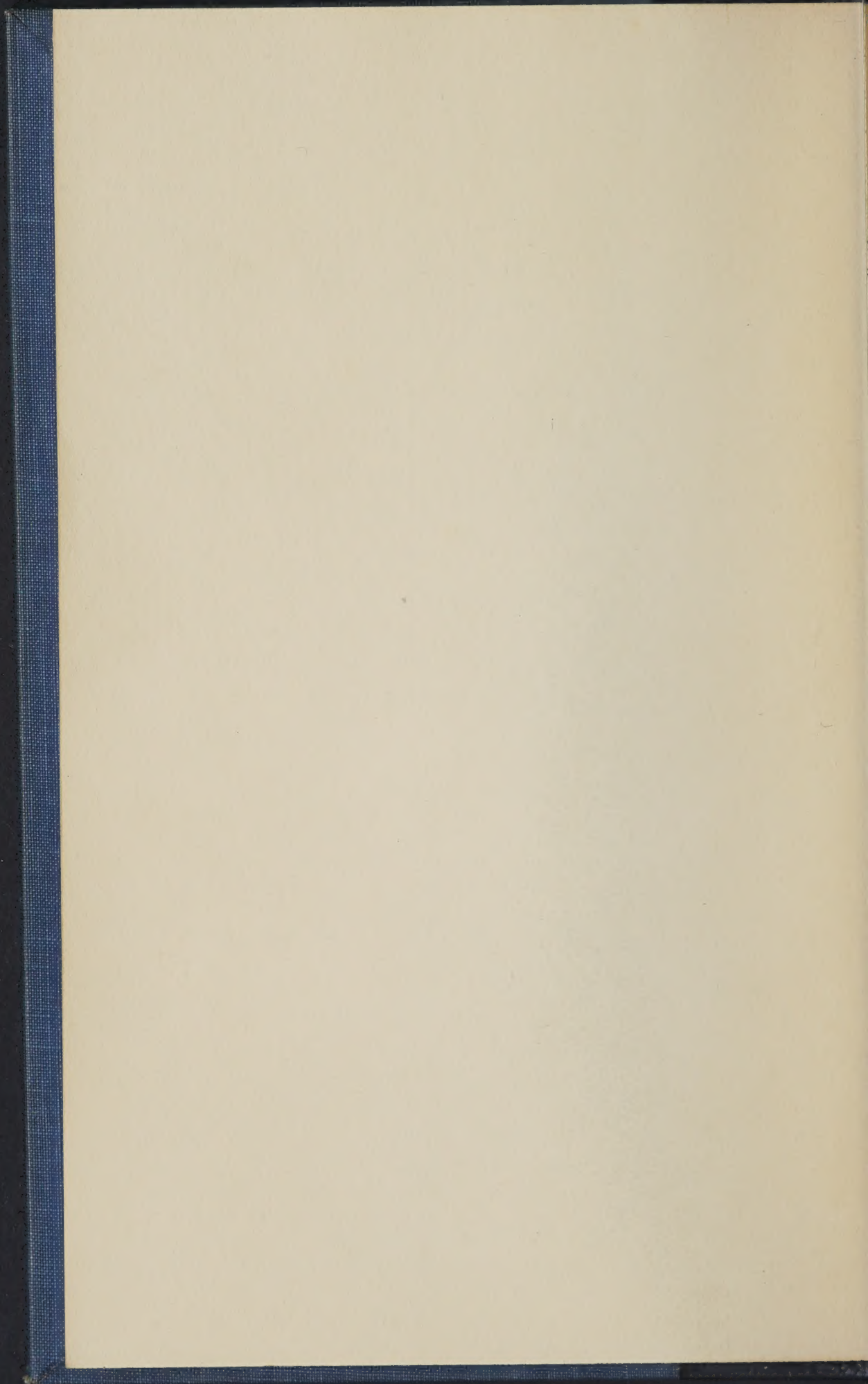
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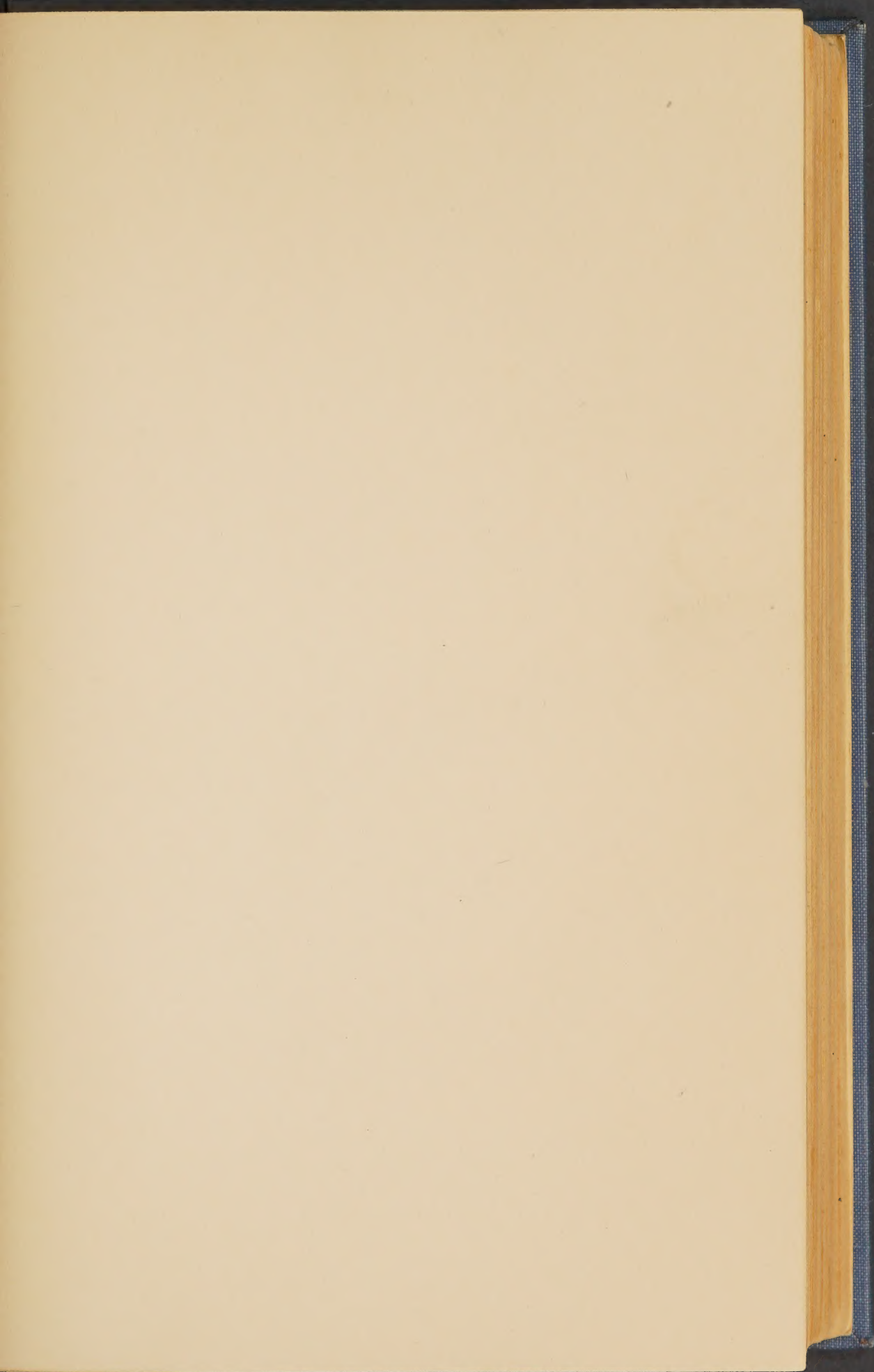
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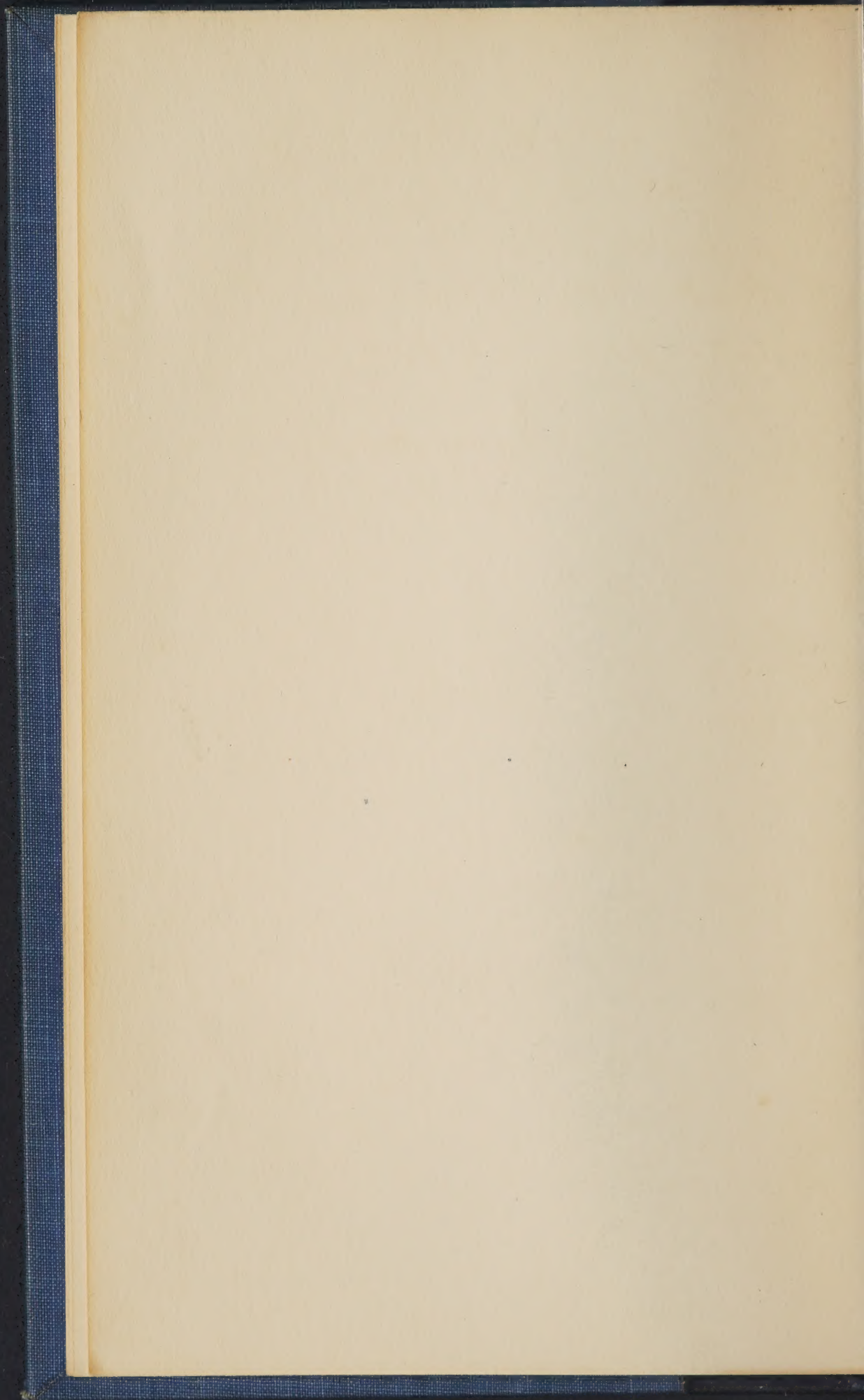
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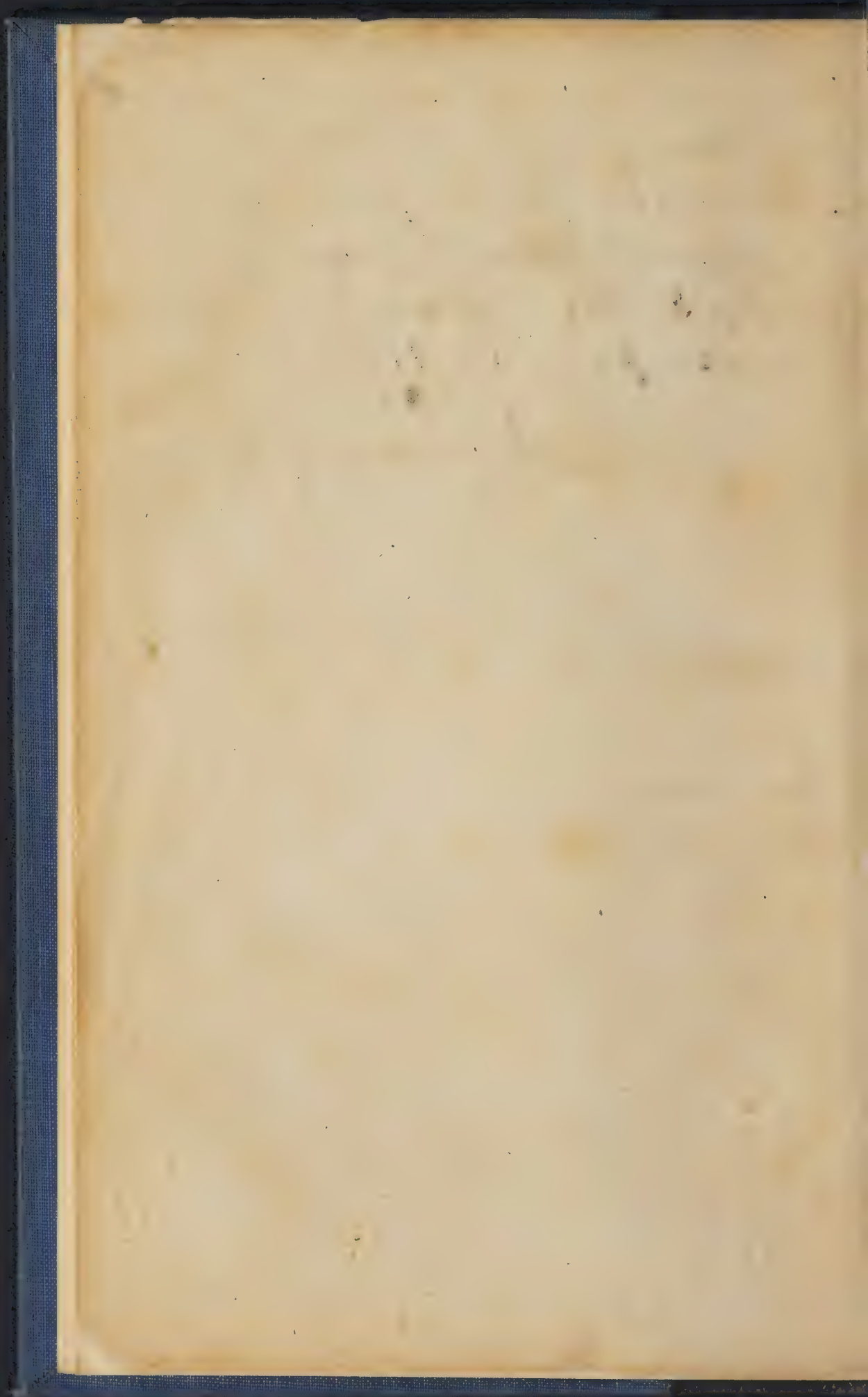




Do

Received this, as a Present
from the Rev. Author, by
the Hands of my very wor-
thy Friend, the ingenious
and Res. Mr. Thomas Bacon.
Ameynotis, Jan. 12. 1762.

Jonas Green



A
T R E A T I S E
O N
V E N T I L A T O R S.

W H E R E I N

An Account is given of the
HAPPY EFFECTS of many
Trials that have been made
of them; which has occa-
sioned their being received,
with general APPROBATION
and APPLAUSE, on account
of their UTILITY in many
ways, to the great Benefit of
Mankind, *viz.*

In refreshing the Noxious Air
of SHIPS, HOSPITALS and
MINES, to the better Pre-
servation of the Health and
Lives of Multitudes.

In preserving the TIMBERS of
SHIPS much the longer from
decaying.

In easily sweetening stinking
CASK WATER and curing
the ill Taste of MILK, from
some Food of Cows.

In new Methods of distil-
ling Plenty of good Water at
SEA.

In refreshing the Air, and keep-
ing up, and regulating, the
Warmth of Melon and Cu-
cumber Frames, and hot
Green-Houses.

And in several other useful IMPROVEMENTS.

P A R T F I R S T.

By *S T E P H E N H A L E S*, D. D.

Clerk of the Closet to her Royal Highness the PRINCESS of
WALES, F. R. S. and Member of the Royal Academies
of Sciences at *Paris* and *Bologna*.

L O N D O N :

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M D C C L V I I I.

AT a Meeting of the ROYAL-
SOCIETY, *June 9, 1743.*

Imprimatur

M. FOLKES, Pr. R. S.

T H E
P R E F A C E.

I*T may not be improper to give an Account how I, who am neither concerned nor skilled in naval Affairs, came first to think of these Ventilators; viz. In the Beginning of September in the Year 1740, I wrote to Dr. Martin Physician to Lord Cathcart, General of the Forces which lay embarked at Spithead, for an Expedition in America, to propose (besides the usual sprinkling between Decks with Vinegar) the hanging up very many Cloths dipped in Vinegar, in proper Places between Decks, in order to make the Air more wholesome: And in case an infectious Distemper should be in any Ship, to cure the Infection with the Fumes of burning Brimstone.*

It was from these Considerations, which often recurred to my Thoughts, that it occurred to me the March following, that large Ventilators would be very serviceable, in making the Air in
Ships

V P R E F A C E.

Ships more wholesome; which is happily confirmed by Experience, as is shown in this Book: and it is a good Symptom that we are got upon a right Scent, when it leads not only to the Thing first sought for, but also to many other useful Discoveries, as we see this does.

We have here an Instance, that the Study of Natural Philosophy is not a meer trifling Amusement, as some are apt to imagine: For it not only delights the Mind, and gives it the most agreeable Entertainment, in seeing in every Thing the Wisdom of the great Architect of Nature; but is also the most likely Means, to make the Gift of kind Providence, this natural World, the more beneficial to us, by teaching us how to avoid what is hurtful, and to pursue what is most useful and beneficial to us.

T H E

T H E
DESCRIPTION *and* U S E
O F
VENTILATORS, &c.

(I.)

1. **B** EING informed, how very Offensive the close confined Air in Ships was, and that chiefly where there were a great number of Men, as in Men of War, and especially, in Transport and Hospital Ships; it occurred to me, that this Inconvenience might, in a great measure, be obviated by means of large Bellows.

2. AND whereas Smiths Bellows and Organ Bellows are heaved with Labour, because in them it is necessary to have the Air much compressed, that it might pass with Velocity and Force through small Orifices, it is proposed therefore to have the Valves and Passages through these Bellows very large, on which account they will be work-
B ed

ed to and fro, with the greatest Ease imaginable, as is evident in the case of common Bellows, which will move up and down, with surprizing Ease, if their Valve be held open with a Finger. And the Case would be just the same, if the Bellows were very large, provided the Valves were proportionably large, and are also made to open and shut easily. For in this Case we only want to move a quantity of light uncompressed Air, from the outside to the inside of the Place where it is desired, or from within outward. And since a Tun or forty Cubic Feet of Air in bulk, weights but 41 Ounces; suppose a Pair of Bellows were so large, as to contain a Tun, yet that Tun of Air would give little Resistance to the contracting Bellows, provided the Valves and Wind-Pipes leading to and from them, were proportionably large: And for the same Reason, the Dilatation of the Bellows would be equally easy. Thus we breathe to and fro through a large Wind-Pipe, about sixteen Tuns of Air in twenty-four Hours, with little or no Labour. And in this consists the peculiar Excellence of this Contrivance; this Method of conveying Air being most simple, and analogous to the way which Nature makes use of, to convey
fresh

VENTILATORS. 3

fresh Air into the Lungs of Men, and of many other Animals, *viz.* by the easy rising and falling of the Midriff.

3. Now in order to make trial of the Method here proposed, I caused two Pair of Bellows to be made in the following manner, *viz.* being accommodated with a Grainery, at the House of the Right Hon. the Lord *Feverſham*, which was thirty Feet long, and contained about two hundred Tuns of Air; in the leſſer adjoining Room, were placed ſide by ſide, two large Boxes, which were ten Feet long, five Feet wide, and two Feet deep, in the clear within ſide. *Fig. 1.* ABCD, deſcribes one of the Boxes, in the middle of which was fixed a broad Partition or Midriff, which was made to move up and down from A to C, on the Hinges X, by means of the Iron Rod ZR, which was fixed to the Midriff at Z, and paſſed through a ſmall Hole in the Cover of the Box up to R; the like Partition or Midriff, was in the other Box, with its Iron Rod ZR; which two Rods were fixed to a Lever or Arm F, G, *Fig. 2.* which moved on the fixed Centre O: So that by the alternate raiſing and preſſing down of the Lever F, G, the Midriſſs were alſo alternately raiſed and depreſſed, whereby theſe

double Bellows were, at the same time, both drawing in Air and pouring it out; one of each Pair of Bellows, being in a dilating state, drew in the Air; while the other two, which were at the same time in a compressing state, blew it out. And that the Midriff might be the lighter, they were made of four Bars or Rails length-wise, and as many across them breadth-wise, which were each three Inches broad and an Inch and quarter thick, swelling in the middle to give them Strength. The vacant Spaces were filled up with thin Pannels of Fir-board, like Wainscot-work.

4. THE Midriff Z X moving to and fro with its Edges very near, *viz.* $\frac{1}{20}$ th of an Inch from the Sides of the Box A, B, C, D, F, E, *Fig. 1.* very little Air, in comparison of the whole, will escape by the Edges; so that there will be no need of leathern Sides, as in common Bellows: which Leather would not only be more expensive, but would also cause them to move much more heavily. And, that the Midriffs may move to and fro with the greater Ease, and without touching the Sides of the Boxes, there is an Iron Regulator fixed upright, *Fig. 1.* to the Middle of the End of the Box A C from N to L; which being half an Inch thick, and an Inch broad,

VENTILATORS. 5

broad, a Notch of the same depth is cut into the middle of the End of the Midriff at N, so that the Midridfs in rising and falling, suffer no other Bearing or Friction than what is made between the *Regulator* and the Notch.

5. THE End of the Box at A C must be made a little circular, that it may be the better adapted in all Parts, between A and C to the rising and falling Midriff; and if the Boards at this End of the Box be but half an Inch thick, such thin Boards will, on being nailed on, the more easily comply with, and be forced into the circular Shape of, the Ends of the Side-boards to which they are nailed. And that these Boards might the better retain their circular Shape, circular Battings were nailed on their Outside: But in the Ventilators on shipboard, for the sake of greater Strength, this circular Form was cut out of a thick Fir-plank. At the other End X of the Midriff a Slip of Leather may be nailed over the Joint at the Hinges, if needful. The Hinges were made of two Pieces of Iron, one of which grasped the End of the Midriff at the Side, the other was a flat Piece of Iron six Inches long, one and a half broad, and half Inch thick, which was let into the Side-

6 *The U S E S of*

board of the Ventilators; these two Irons were riveted together with a Rivet half Inch thick, which was the moving Joint.

6. ALL the Boards of which the Boxes are composed ought to have their Joints well secured with *Grooves* and *Tongues*, and have brown Paper pasted over them; and especially near both the Ends they may be fastened with Wood-screws, to draw out, in order to rectify any thing that may be amiss there. But these Wood-screws will rust in Ships, too fast to be moved, unless well greased.

7. THE eight large Valves for the Air to pass through were placed at the Hinge-End of the Boxes B K, *Fig. 2.* 1, 2, 3, 4, 5, 6, 7, 8. The Valve, Numb. 1. opens inward to admit the Air to enter, when the Midriff is depressed at the other End, by means of the Lever F G. And at the same time the Valve 3, in the lower Ventilator, is shut by the compressed Air which passes out at the Valve 4. But when that Midriff is raised, then the Valve 1 shuts, and the Air passes out at the Valve 2. And it is the same with the Valves 5, 6, 7, 8, of the other Box; so that when by the Motion of the Lever F G, the Midriffs are alternately rising and falling, then two of the Ventilators are constantly drawing
in

VENTILATORS. 7

in Air, and two of them at the same time are blowing it out at their proper Valves; the Air entering at the Valves 1, 3, 6, 8, and passing out at the Valves 2, 4, 5, 7.

8. THERE was fixed to the Ventilators before the Valves 2, 4, 5, 7, a Box Q, Q, N, M, *Fig. 3.* as a common Receptacle for all the Air which came out of those Valves; which Air passed off through the Trunk P, which was a Foot square in the Clear within; this Trunk passed thro' the Partition-wall of the two Rooms. The Valves were hung on tanned Leathern Hinges, which were fixed to their upper Side, which is best, because that Position will cause them always to shut of themselves by their own Weight.

9. I MADE the Openings of the Valves at first, twelve Inches long and six wide, which was one hundredth Part of the Breadth of each Midriff, they being fifty square Feet broad; but on trial, I found these Openings too narrow for the great Quantity of Air which was to pass thro' them. I then made the Openings two Feet long, and seven Inches wide; which I found to be a sufficient Degree of Wideness, that being nearly $\frac{1}{4}$ th Part of the Breadth of each Midriff: which were moved up and down easily enough, notwithstanding each
of

of them weighed on the Lever at R R, *Fig. 2.* thirty Pounds; which very little increased the Force requisite to move the Lever, because they counter-balanced each other's Weight: on which account two Pair of these Bellows, in this horizontal Posture, may be worked with more ease than one Pair.

10. It is very requisite to make the Valves as light as possible; for when they weighed two Pounds, being made of red Fir half Inch thick, they did not open wide enough for the Air to pass freely. But when they were made about $\frac{1}{4}$ th Inch thick, and of lighter white Fir, weighing but fifteen Ounces; being then raised, by the rushing Air, to an Opening of about forty-five Degrees, or half open; then the Midribs were worked to and fro with ease enough. But to prevent the warping of these thin Valves, it was needful to let in, tack and glew on them, Pieces or Fillets across each of them, *viz.* one at each End, and one in the Middle. It will contribute much to their Lightness, to have the lower more moveable Part of the Valves much thinner than the Upper Part; which will require a thicker Substance of half an Inch, to nail the Hinges fast on.

11. WHEN

VENTILATORS. 9

11. WHEN the Box QQ. with its Trunk P, was put over the Valves 2, 4, 5, 7. *Fig. 2*, and 3. so as to receive the Air which rushed out of them; then the Midribs required a sensibly greater Force to move them up and down: which shows that the Trunk P was not wide enough, notwithstanding it was a Foot square in the Clear within side. Whence I found, that the working of the Bellows, faster than at the rate of sixty Strokes in a Minute, did not proportionably increase the Quantity of Air that was conveyed out of them: for when they worked at the rate of eighty Strokes in a Minute, the Air not being able to pass off so fast at the Nose, was much compressed in the Ventilators; which Air dilating again as the Ventilators dilated, so much the less Air was sucked in at each Dilatation of the Bellows, and consequently so much the less passed off. Which is a Thing well worth the taking notice of, else there may be much superfluous Labour, when the Bellows are worked too fast, for the Air to pass as freely and fast off: for when the Bellows are large, they will convey great Quantities of Air, without being worked very fast, which will much lessen the Labour of working them. See farther Improvements
in

in the Make of Ventilators in Part II. 193
to 197,

(II.)

12. **I**T is easy to make an Estimate of the great Quantities of Air, that are conveyed by these Bellows : For suppose the Midribs rise and fall one Foot at each Stroke, which is enough, and that sixty times in a Minute, that will amount to seventy-five Tuns in a Minute, and four thousand five hundred in an Hour ; which will amount to one hundred eight thousand Tuns in twenty-four Hours. And the Trunk P being a Foot square, the Velocity of the Air, as it passes out thence, will be at the rate of three thousand Feet in a Minute ; which is at the rate of thirty-four Miles in an Hour. This, supposing no Air escaped between the Edges of the rising and falling Midribs, and the Sides of the Boxes, for which, an Allowance is to be made ; for which, supposing eight Miles are deducted, a large Allowance ; That will be nearly the Velocity with which a Race-horse goes, who runs four Miles in nine Minutes, which is at the rate of 266 Miles in an Hour ; and more than thrice the Velocity with which Fans impel Air, in winnowing
Corn,

VENTILATORS. 11

Corn, when they are turned at the rate of seventy Revolutions in a Minute.

13. MONSIEUR MARIOTTE found that a pretty strong Wind moves twenty-four Feet in a Second of Time, which is at the rate of one thousand four hundred and forty in a Minute; that is, at the rate of twelve and a half Miles in an Hour: which is about half the Velocity, with which the Wind rushes out of these Ventilators.

14. IN my *Statical Essays*, Vol. II. p. 326. it was found that the Air rushed out of a Pair of Smiths Bellows, at the rate of 68.73 Feet in a Second of Time; that is, at the rate of seventy-eight Miles in an Hour, when compressed with a Force equal to the Weight of one Inch perpendicular Depth of Mercury, laying on the whole upper Surface of the Bellows.

15. BUT there is another way whereby to estimate the Velocity, with which impelled Air passes out at any Orifice: this I tried by hanging a light Valve, which was six Inches long, and three and a half broad, over the Nose of the Bellows, by pliant Leathern Hinges, which was agitated and lifted up much, from a perpendicular to a more than horizontal Position, by the Force of the rushing

ing

ing Air. Whereas in another ventilating Machine, composed of a Wheel with Fans, in a Drum, such as that over the *House of Commons*, described in *Agricola de Re Metallica*, and in the *Philosophical Transactions*, a like Valve was moved very little, by the Force of the Air which it conveyed; which evidently shews the great Difference there is, in the Velocities, and consequently the Quantities of Air that are conveyed by these Machines. There is another more accurate way of estimating the Velocity of Air, viz. by holding the Orifice C of an inverted Glass Siphon or Crane full of Water; such as is described, *Fig. 9.* C R I, opposite to the Stream of Air, whereby the Water will be depressed in the Branch C R, and raised in the other Branch I, in proportion to the Force with which the Water is impelled by the Air. When this Crane was applied to the Wheel Ventilator, the Force of the Air, which was sufficient to blow out a Candle, moved the Water in the Crane very little: whereas when the same Crane was applied to the Nose P of the great Ventilators, *Fig. 3.* the Water was so much agitated, that it made large Vibrations up and down in the Crane. See more of this Part II. 198.

VENTILATORS. 13

16. Now as to the Velocity of this Wind, it is to be considered, that as the specifick Gravity of the Air, is to that of any other Fluid, so reciprocally is the Square of the Space, which that Fluid moves in any given Time, to the Square of the Space which the Air, by the same Impulse, will move in the same Time. And the specifick Gravity or Weight of Water, being to that of Air as eight hundred eighty-one to one, consequently the Air moves thirty times faster than Water would do with the same Impulse.

17. ACCORDING to the different Position of the Valves, these Bellows may be made, either to convey good Air into a Room, which would drive out the bad Air at some proper Places, or to draw the rancid Air out of a Place, which would be succeeded by good Air.

18. I FILLED the Room in which these Ventilators were, with the Smoke of wet Hay and Shavings; and then, having first conveyed away the smoking Fuel, on working the Bellows, the Smoke was in a few Minutes conveyed thro' the Ventilators out of the lesser Room into the larger Room: Hence we see how effectually they will purify the Air in a Room.

19. I FOUND

14 *The Uses of*

19. I FOUND that a Handkerchief held near the Nose of the Ventilators waved, and was agitated to and fro very briskly; and a Candle was not only instantly blown out there, but even at twenty-five Feet distance, its Flame was blown side-ways; and the Agitation of the Air was manifestly to be felt at that Distance.

20. WHEN it is required to convey great Quantities of Air into Mines, or Magazines, or in drying Malt or Hops, &c. these Ventilators, whether in an horizontal Posture, as in *Fig. 2.* or standing upright as in *Fig. 4.* may be worked by a Horse, or Stream of Water, turning a Crane, by means of Cog-wheels.

21. WHEN fresh Air is to be conveyed into a Mine, or bad Air to be drawn out of it, for one or the other of these is to be done, according as the noxious Damps are specifically lighter or heavier than the common Air, then the Box *Q Q*, *Fig. 3.* is to be fixed over the Valves, 2, 4, 5, 7, with the Trunk *P*, which is to be continued down by additional Tubes, or Trunks, to the farthest Part of the Mine. There is in *Agricola de Re Metallica*, not only a Description of the abovementioned
Wheel

VENTILATORS. 15

Wheel with Fans in a Drum, but also of large Bellows, which are moved by Water or Horses, to convey Air into Mines : but as these Bellows are made like the Bellows at Iron Forges, with leathern Sides, they will move much heavier than these with Midriffs, which convey Air both rising and falling, which the others cannot do.

22. WHEN there is occasion to convey much greater Quantities of fresh Air into any Place than the Ventilators, *Fig. 2.* can convey, that may easily be effected, by having several of the like Ventilators lying on each other, whose Midriffs may all be moved up and down, by the same prolonged Iron Rods R Z, *Fig. 2.* or by the Rods f. f. Part II. Plate III. *Fig. 13.*

23. WHEN the Ventilators lie horizontally, as in *Fig. 2.* then it will be best to have two Pair of them, because they will work much easier than one Pair, on account of the Weight of the Midriffs, which in *Fig. 2.* counter-balance each other, on the Balance R O R ; whereas one alone would burthen the Person who moves it, with its Weight of thirty Pounds.

24. BUT

24. BUT if the Ventilators are placed in a perpendicular upright Posture, so as to have the End Z uppermost, as in *Fig. 4.* then, as the Weight of the Midriff would rest on its Bottom, only one may be used, and those larger or smaller, as shall be needful. If the Ventilators are fixed in this upright Posture, it will be requisite to place them upon the Box B K L M, as in *Fig. 4.* for the more commodious conveying the Air from them; the manner of doing which is expressed in *Fig. 5.* where the End of the same Box B L, is covered with the Board X Z, with two large Holes at X and Z, cut in it for the Air to pass down thro' X, when the Air in the Side X of the Ventilators is compressed by the Midriff; and thro' the other Hole Z, when by the Return of the Midriff the Air of Z is compressed. In the other half of the Box Q K M the Board X Z is taken off, to shew the manner of the Passage of the Air from the Holes X Z, thro' the Passages Y, where Valves are fixed, to prevent the returning back of the Air, which goes out at the Nose T Q. The Partition R R is necessary to prevent the Air's ascending up thro' X, while it descends thro Z, and *vice versa*. The Air is drawn into these Ventilators at the large Valves N N.

25. WHEN

VENTILATORS. 17

25. WHEN it shall be requisite to convey Air into some of the Windings and Turnings of Mines, or to the Corners of large Rooms, as in Magazines, &c. this may easily be done by means of large round or square Trunks, made of Board or Tarpawlings, which may be distended by Hoops or Poles. Such Trunks will be lighter than if made of Boards to move to and fro, especially near the Places where the Miners are digging.

26. MINERS observe in digging a Well or Shaft, that by having a long Trunk in it, the Air descends in a sufficient Quantity, to make the Air in the Well fit to breathe in. The small Ventilators described in Numb. (74.) will be very serviceable, when the Air of Wells is noxious.

27. IN *Lowthorp's Abridgment of the Philosophical Transactions*, Vol. II. p. 375. there is an account of four Sorts of Damps observed by the Miners in *Derbyshire*: The first is called the common Sort, perceived at first by the Candles burning orbicular, and the Flame lessening by degrees; the Effects of it upon Human Bodies are Faintings, Convulsions, Suffocations. The second is what they call the *Pease-bloom Damp*, which the Miners imagine, is the Steam of a Vegetable growing
C lower

lower than the Level. The third is the most noxious; the Miners say they see in the highest part of the Roof, in those Passages which branch out from the main *Groove*, a round thing of the Bigness of a Foot-ball, with a Film or Skin about it, which when broken by accident, disperses itself, and suffocates all the Company. The fourth is the *fulminating Damp*, resembling in its Nature and Effects, Gunpowder, or that Matter which produces Thunder. When this takes fire, it kills by Explosion, as Thunder and Gunpowder. The Remedies of the Miners, are by Air-shafts, and Perflation, with artificial Wheels and Bel-lows. The Air-shaft is usually a good distance from the *Groove*, thro' which things are conveyed up and down the Mine: And the Air is driven down the Air-shaft by means of Skreens, which drive the Wind down like a *Wind-sail* in Ships; or by a Fire suspended in the middle of the *Air-shaft*, it is drawn upwards, as in a common Chimney. And from the *Groove* to the *Air-shaft*, there passes a Channel called a *Drift*, thro' which the Air is conveyed either to or from the *Groove*. But when the Air in Mines is very noxious, it seems requisite for fresh Air to be conveyed incessantly, thro' large Trunks, to the very
Angle

VENTILATORS. 19

Angle or Part of the Mine, where the Miners are digging. On foul Air in Mines, see more Part II. Numb. 34.

28. IN the case of Goals, Work-houses, and Barracks, where the People have full leisure to work the Bellows, they might be placed, either against a Wall, or be fixed breadth-wise to the Cieling, or in any other Position that shall be found most commodious. They ought to be so placed, as that they may best serve several Rooms in their turns, according as their respective Pipes should at pleasure be open'd or shut by Sliders. And there must be a Provision made, on the opposite Side of the Rooms, for the old foul Air to pass off, in proportion as the fresh Air comes in, or *vice versâ*. See more of this Part II. Numb. 230.

(III.)

29. **A**S to *Hospitals*, tho' fresh Air is of great importance to the Sick, yet it must be conveyed into or out of their Rooms, in an almost imperceptible gentle manner. See more of this in Part II. 199. 392.

30. A VENTILATION of warm dry Air would also be of service to Trees and Plants in Green-houses, where it is well known that

an Air, full of the rancid Vapours, which perspire from them, is very unkindly to them, as well as the frowzy Vapours of human Bodies are to Men. For I have shewn in my *Vegetable Staticks*, that fresh Air is as necessary for the healthy State of Vegetables, as of Animals. See more of this Part II. 376 to 383.

(IV.)

31. **A**S to the Case of Ships, where fresh Air is of the utmost importance, but Room very scanty on account of the great Croud and Cumber of Persons and Things on board, it was more difficult to find a commodious Place where to fix the Ventilators. Dr. *Lee* having heard of them, he first, and then the rest of the *Right Honourable the Lords Commissioners of the Admiralty*, were pleased to send for me, to be further informed about them ; and thereupon were pleased to order the Master Ship-wrights, and other Officers of *Woolwich* and *Deptford* Yards, to consider of the most commodious Place where to fix them in a Ship. Which was judged to be under the Fore-part of the *Orlop* or lowest Deck, next to the Carpenter's Room. And accordingly they were fixed there, between the main
Beams

VENTILATORS. 21

Beams of the *Orlop*, on board his Majesty's Ship *Captain*, a seventy Gun Ship; with their Valve-end and Nose next to the Side of the Ship.

32. THEIR Dimensions being, in proportion as expressed in *Fig. 2.* ten Feet long, and each four Feet three Inches wide, in the Clear within side; and thirteen Inches deep; one Inch of which being occupied by the Midriff, there remained a Foot depth, for it to rise and fall in.

33. THE Midriff was made of Fir Wain-scot-work, with thin Pannels of Wood grooved into four Rails, which run lengthwise, and as many across, which were tenanted into each other; the long Rails were four Inches broad, and an Inch thick at each end, swelling gradually, to full half an Inch Thickness more at their Middle, thereby to give them greater Strength; the Rails which went across at each end were ten Inches broad: In these, about six Inches from the ends of the Midriffs, were fixed the Iron Rods ZR, *Fig. 2.* being fastened there with a Screw and Nut, on Iron Plates on the upper and lower side, which were four Inches broad, thereby to secure the Wood of the Rail from galling and wearing. The Iron Rods RZ, *Fig. 2.* which were flat at their

22 *The Uses of*

Upper-part, being an Inch and half broad and half Inch thick, with several Holes, whereby to pin them fast, into Mortices R.R. of the Lever F G, were, from below the Lever, about three quarters of an Inch square in substance down to Z, where they entered into the square Iron Socket T Z, into which they were fastened by an Iron Key I; by taking out of which Key, the Iron Rods R R, with the Lever F G, and the middle Post O, might be removed, or unshipped as they term it, in time of Action, if required: Nothing of it remaining above the Surface of the Ventilators or Floor of the *Orlop*, but about two Inches length of the Iron Socket Z, wherein to fasten the Rods R R again, with the Lever F G, which was twelve Feet long. The Lower-part of the Iron T Z had a Joint near the Midriff, like two Links of a Chain, or two Eyes in each other, whereby the Rod Z R readily complied at that Joint, which the double Motion caused by the rising and falling of both the Midriff and the Lever. The Hinges on which the Midriffs moved at their other ends, were made as described in Number (5.)

34. The outside Fir-boards of the Ventilators were an Inch and half thick, as also that in the middle between them which was com-

VENTILATORS. 23

mon to both ; the circular Board C, D, D, was a thick Fir-plank. The Openings of the Valves 1, 2, 3, 4, &c. were six Inches deep, and twenty-two Inches long ; the Valves themselves were an Inch broader and longer, and their Borders, as well as the corresponding Borders of the Valve-holes which they fell against, were lined with a Lift of Woollen Cloth, both to prevent their making a noise, and to save them from being broken by falling on hard Wood.

35. THE Valves being each six Inches deep, the Partition between them four Inches, and the Spaces above and below them each three Inches, in all twenty-two Inches ; it was necessary to make the Ventilators thus deep at this end, for near two Feet length, both that there might be room for Valves of such a depth as was necessary ; and also that the Valves, which draw in Air, viz. 1, 3, 6, 8, might have full room to move inwards. And that there might be room for the upper Valves 1, 6, to move freely inwards, it was necessary to place the upper Surface of the Midribs, eight Inches below the upper Cover of the Ventilators, leaving only four Inches clear, for the Air to pass between the Midribs and the Bottom of the Ventilators.

36. IT was also necessary to have the Valve-box Q M M twenty-two Inches deep, and eighteen Inches broad from Q to N, not only that there might be room for the Valves, 2, 4, 5, 7. to open, but also as much more room beyond the reach of the open raised Valves, for the Air to pass thro' the Hole L, (there being in this Case, no end Hole P P) into a Trunk about a Foot square, which conveyed the Air near the Side of the Ship, through the Gun-deck and Upper-deck, either out, through a Hole cut in the middle of the Gunnel, or up, to its Top.

37. THESE Ventilators were fixed under the Carlings, which they were unwilling to cut away in a new Ship, till they had been first tried and approved of. But it is agreed that it will be better, to cut away the Carlings, so as to make room for the upper Surface of the Ventilators, to be even with and make a Part of the Floor of the Orlop; whereby they will not only take up so much the less room in the Hold, but can also more commodiously be come at, in order to repair any Part of them: Here they are placed well out of the way in time of Action.

38. THEY are worked by a Lever twelve Feet long, by two Men standing upon the Orlop.

VENTILATORS. 25

Orlop. And being each ten Feet long, four Feet three Inches wide, and thirteen Inches deep, throw out at the rate of a Tun of Air at each Stroke, sixty Tuns in a Minute; three thousand six hundred in an Hour; and eighty-six thousand four hundred Tuns, in twenty-four Hours; which passing off thro' a Trunk a Foot square, the Air rushes out with a Velocity of twenty-five Miles in an Hour.

39. In this Estimate, there is an Allowance made, of two Cubic-Feet and half of Air, to escape at each Stroke, between the Edges of the Midribs and the Sides of the Ventilators.

40. BUT notwithstanding this great Velocity of the Air here; yet the Motion of it downwards into the Hold, to supply what is carried off, is so very gentle, that it cannot be perceived; because the Sum of all the open Passages for it, through the Gun-deck, is an hundred and five Feet square; so that the Air descends through them an hundred and five times slower, than it passes off at the Nose of the Ventilators: And as the Sum of the Openings through the Upper-deck, is fifty-seven square Feet, the Descent of the Air through them, must be proportionably slower; besides that a further Allowance is to be made, for what Air enters at the Joints of the Port-holes

1 when

when shut ; and through the *Hawse*, or Cable-holes at the Head of the Ship.

41. THESE Ventilators may therefore be used with great Safety to the Sick and those who are sleeping, at such times as the Wind-sail would, by reason of the Strength of the Wind, convey Air with too much Violence. They will also be of great Use in a Calm, when the Wind-sail can do little good ; also when under sail, at which time the Wind-sail is not used. It is therefore wrong to conclude that these Ventilators are useless, because a Wind-sail will, with some Degrees of Wind, convey much more Air than these Ventilators : For it is not the ventilating of a Ship, now and then with a Wind-sail, when Wind and Weather serve, that will suffice ; it ought to be done daily, if a due Regard be had to the Health of the Ship's Crew. For since it is certain, that nineteen Ounces and a half of Matter perspire from a Man here in *England* in twelve Hours ; this great Quantity of Vapour, together with the Stench that incessantly arises from the Bilge-water, and from the hot stagnant, putrid unwholsome Air in the Hold, must needs make it very adviseable and desirable, to be almost continually refreshing so bad an Air, either with the Wind-sail, when that

can

VENTILATORS. 27

can properly be used, or else with the Ventilators, which are intended to supply the Defects of the Wind-fail. 'Tis for want of being thoroughly sensible of the vast Quantity of rancid noxious Vapours, which are incessantly exhaling from a great Number of live human Bodies, confined in a close Place, that makes many apt to imagine that it is sufficient for Health, if such bad Air be ventilated away and exchanged for good Air, at the distance of many Days, between each Ventilation: As these hurtful Exhalations are too subtile to be seen floating in the Air, many cannot easily be persuaded that such an Air is unhealthy; notwithstanding they are sufficiently warned of it, by the offensive Smell; which Offensiveness does indeed much abate by Use.

42. THERE may be one or more Setts of Ventilators of different Sizes in a Ship, in proportion to the different Burdens of the Ships. And in Hospital-ships, where they cover the Port-holes with Canvas, which lets the Air in gently, by drawing out the bad Air below there will be a constant gentle Supply of fresh Air.

43. VENTILATORS will be of great service especially in new Ships, which are observed to be the more unhealthy, on account of the
greater

greater Quantity of sappy Wreak which arises from new Timber, and makes the confined Air the more unwholsome.

44. THEY will also be an effectual Preservative of Horses in Ships, where they are sometimes suffocated, when in a Storm there is a Necessity to shut the Hatches down.

45. VENTILATORS will also drive out of the Hold of a Ship the dangerous confined Vapour, which arises from Corn; which is so very noxious, that sometimes they dare not venture into the Hold, till after the Hatches have been opened for some time.

46. THIS Ventilation will also be of service to preserve not only several kinds of Goods, but also the Timbers and Planks of the Hold itself, when laid up in ordinary, as well as when in use; and will make the Air in the Hold less noxious, tho' it will still be offensive to the Smell, by reason of the Bilge-water, which is made the less offensive, by often letting in of sweet Water from the Sea, and then pumping it out; which good Practice ought to be continued, notwithstanding the Use of the Ventilators.

47. As to the principal Objection, *viz.* the Labour and Difficulty of working these Ventilators, how frivolous and groundless is it,

V E N T I L A T O R S. 29

it, when the matter is rightly considered ; for as they are chiefly wanted, where there is a great Number of Men, so the Labour of it equally divided among them, is very inconsiderable ; for if two Men can hold to work them for a Quarter of an Hour, four Men, by changing Hands *Spell* and *Spell*, as they term it, may well work for an Hour. And suppose there be five hundred or four hundred and eighty Men in a Ship, and every one takes his Share of the Work ; then once in five Days it will come to every Man's Turn, to work at it for Half an Hour. And suppose there be in a Transport, or *Guinea* Slave-Ship, two hundred Men, as there is often about that Number ; then it will come to every Man's Turn to work the Ventilators for Half an Hour, once in forty-eight Hours ; but here, as the Ventilators will be less than the above described Ventilators, so will the Labour of working them be also less. This, supposing it necessary to do it incessantly Night and Day : which need not be in Men of War, when the Port-holes can be opened, and there is any degree of Wind ; which, suppose it be half the Time of the Crew's being on ship-board, then it will come to each Man's Turn but once in ten Days. This Calculation is made
on

on a Supposition that every Individual takes his *Spell* at the Ventilator ; but let us allow an Abatement of one-fifth for Officers, Sick, &c. then will the Work be no more than Half an Hour to each Man in eight Days. But suppose it were to be incessant, can Half an Hour in five Days be thought so hard and great a Degree of Labour, as to render the working of the Ventilators an impracticable Thing ? Is not the Benefit proposed thereby, *viz.* the saving yearly the Lives of Thousands, a sufficient Reward for so small a Pittance of Labour ? Shall it be said of the brave and undaunted *British* Sailor ; that rather than pull his Hand out of his Bosom, and work for Half an Hour, once in ten Days, he will chuse to lie down and suffer that brave manly Spirit to be suffocated in a frowzy Stench, a Stench that has destroyed the Lives of Millions of the stoutest and bravest : for the Lamp of Life is sooner thereby quenched, than many are aware of. One would think it altogether needless to use many Arguments, to prevail with Men, to make use of so easy and certain a Way, to preserve their own Lives and that of their Comrades. But I am sensible that narrow Minds, who don't care to go out of an old beaten, tho' very bad Track, are apt to view
new

new Proposals, tho' never so rational, only on their worst Side, without duly weighing the Conveniences. This was, within Memory, the Case of a very useful Contrivance, for steering the Rudder by, with great Ease and Safety, by means of a Wheel above Deck. And I make no doubt, but that whatever Discouragement this may meet with at first; yet its great Benefit in preserving the Health and Lives of Men, will hereafter recommend it to the general Esteem and Use of Mankind: For I cannot think that Men will chuse to sicken and die, in and by a Stench, in an old experienced Way, when they have it in their Power to prevent it, by rational and effectual Means. It is well known that all must perish in a Ship, if they will not be at the pains to work the Pumps at proper Times; and should not the same Motive of Self-preservation induce them chearfully to work the Ventilators, which will not only conduce to the greater degree of Health of all, but will also, by God's Blessing, be a Means of preserving the Lives of many? And let it be remembered, that the Labour itself will conduce to Health, and be preventive of the Scurvy, a Disease which Sea-faring People are subject to.

48. IF a Windsail were effectual for the Purpose, why do they suffer the Air in Transport-Sips, and especially in *Guinea* Slave-Ships, to be so intolerably nauseous? and even in Men of War, it is well known to be very offensive, especially when the Ports are shut. But this Method is here proposed, in hopes that these Inconveniences might, in a good measure, be prevented by having a constant gentle Supply of fresh Air, not only now and then, when Wind and Weather would permit, but incessantly, or at least often; in the same manner as Animals are supplied therewith, whether sleeping or waking.

49. THESE Ventilators may, not improperly, be called the Lungs of a Ship: And I make no doubt but that they will well deserve that Name, on account of the great Means of Health they will be to its Vitals the People on board. For such Quantities of fresh Air will greatly contribute to make the Air in the closest Parts of the Ship more wholesome, for Sea-Air is Healthy.

(V.)

50. **I**T ought in reason to convince us of the great Importance that plenty of fresh Air is to our Welfare, when we consider that the great Author of Nature has allotted near
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VENTILATORS. 33

one-half of the Trunk of our Body for the Office of Respiration, or Breathing only : can any one therefore be so unreasonable, as to grudge the little Space, these will take up in a Ship, or the small Labour that they will require, to furnish great Plenty of fresh Air? Were an Animal to be formed of the Size of a large Ship, we are well assured by what we see in other Animals, that there would be ample Provision made to furnish that Animal with a constant Supply of fresh Air, by means of large Lungs, which are formed to inspire and breathe out Air in the same manner as these Ventilators do. Can it therefore be an unreasonable or an improbable Proposal, to attempt to furnish Ships, Gaols, Hospitals, &c. in the same manner with the wholesome Breath of Life, in exchange for the noxious Air of confined Places, which is rendered unwholesome, by the great Quantity of rancid Vapours, which are incessantly exhaling from human Bodies; and are the Occasion of much Sickness, and of the Death of Multitudes?

51. IT is well known that Infections are principally drawn in by the Breath; thus the Fumes of fermenting Wine, Beer or Vinegar, which instantly kill any Animal that comes within the Reach of them, produce their pernicious

noxious Effects by being drawn into the Lungs. Which is further confirmed by the following Experiment made by Dr. *Langrish* of *Petersfield* in *Hampshire*, viz. He cut open the Wind-pipe of a live Dog, and stopped the upper Part of the Wind-pipe towards the Mouth with a Cork; the Dog breathing freely thro' the other Part. Then the Dog's Head being put into a round Hole cut in the End of a large Box, with a Collar of Leather which was nailed round the Hole and tyed round his Neck, to prevent the Fumes of burning Brimstone from coming out to offend his Breath: Things being thus prepared, the Dog received no Harm as to his Life; notwithstanding the Fumigation was so strong, and continued so long, as to put out his Eyes.

52. THE Consideration of the great Quantity of rancid Vapours that incessantly exhales from human Bodies, especially where there are a Multitude confined in a small Compass, fully evinces the Insufficiency of any Attempts to make the Air in Ships wholesome, by only a few Hours Ventilation in every twenty-four Hours; it were to be wished that there should not be so much as one Hour without Ventilation when the Ports are shut; but when the Dews fall in greatest quantity, it may perhaps
be

VENTILATORS. 35

be adviseable to cease conveying the external Air into a Ship, for about an Hour at that Time. Dews do not always fall in greatest plenty soon after Sun-set, but in some Climates some Hours after, as I am informed, *viz.* sooner or later in proportion to the different Heights to which the Vapours are raised by the Heat of the Sun. The Ventilation must therefore be regulated as Experience shall show to be best, in different Circumstances of the outward Air, as to its Temperature of Heat or Coldness, Moisture or Driness: But that must be an uncommon bad Temperature of the outward Air, to be at any time worse than the inward frowzy Air of a Ship; and consequently Ventilation can rarely be unseasonable.

53. IT is well known, that the Vapours which arise from human live Bodies, are extremely corruptible; hence it is, that the Air of Prisons often produces mortal Distempers. And doubtless, where the Air in Ships is much more rancid than in Prisons, on account of great Numbers of Persons on board, it must needs also tend to make them sickly, and less able to contend with the Inclemency of Air, that a Change from a cold to a very hot Climate causes; which, I have credibly been informed, has sometimes been observed to be

the Case, especially where they have been too numerous in the Ship during the Voyage.

54. THERE is so great a Quantity of Vapours carried off by Respiration or Breathing, that I found by Experiments, that more than a Pound-weight of Moisture goes off by the Breath in twenty-four Hours; and that somewhat less than two Gallons of Air, being breathed to and fro, for two Minutes and a half, was so furcharged with Vapours, that I could not possibly breathe it any longer. See *Statical Essays*, Vol. II. Pag. 323, 326. And it is further to be considered, that a close confined Air, in which there are many Persons, is filled not only with the Vapours arising from their Breath, but also with what perspires off their Bodies; which Respiration and Perspiration both together, are equal to the Quantity of half the Meat and Drink which we take in daily; which is estimated to be about thirty-nine Ounces in *England*, and is much greater in hot Climates. And if the Quantity of Vapours which arise from one Man in twenty-four Hours is thirty-nine Ounces, then in an hundred Men it will amount to two hundred forty-three Pounds, and in five hundred Men to one thousand two hundred fifteen Pounds Weight. Not that the Air in the most capacious

V E N T I L A T O R S. 37

cious Ship can possibly contain all this Quantity of Vapours at once ; nor could any living Creature breathe therein, if it were so surcharged with them : but yet this Estimate shows, how very great the Stench of such an Air must necessarily be ; which not only retards Respiration, but also Perspiration, which is very prejudicial, Dr. *Hoadley*, in his ingenious *Lectures on Respiration*, observes, “ That
 “ the Air itself has so great a share in the Ac-
 “ tion of Respiration, and is so necessary like-
 “ wise to the Health and Vigour of the Body,
 “ that no remarkable Alteration can be in it,
 “ without our being very sensibly affected by
 “ it.—Consequently, when the Air we breathe
 “ is loaded with Vapours, which either ren-
 “ der it too warm, or destroy its Elasticity,
 “ or both, it becomes unfit for Respiration,
 “ and interferes with the Action of breathing.”
 —And he further observes, “ that unless the
 “ Chyle, which is mixed with the Blood, be
 “ brought to the Lungs in proper Quantities,
 “ and endowed with proper Qualities ; unless
 “ the Discharges thro’ the Sides of the Vesi-
 “ cles of the Lungs be regularly and duly
 “ performed ; unless a proper Quantity of
 “ Air-particles be absorbed, to supply the
 “ active Principles, so necessary to the Warmth

“ of the Blood, and the Cohesion of its Parts;
 “ it must by degrees grow less and less fit for
 “ the Purposes of Life; So that by degrees
 “ the Blood will be so impaired and broken,
 “ that when it most wants the Assistance of
 “ the Lungs, it will be brought thither, when
 “ it is only fit to choak up and clog the Vesi-
 “ cles, and capillary Arteries, so as to prevent
 “ the receiving the Service it could receive in
 “ passing through the Lungs.” — Hence, ’tis
 no wonder that when we breathe an Air, thus
 loaded with Vapours, it should be apt to cause,
 what are called Gaol-distempers; which In-
 convenience might in a great measure be pre-
 vented, if such close Places were ventilated
 with fresh Air; for want of which, many un-
 happy Persons are not only deprived of Li-
 berty, in Gaols, but too often even of Life also.

55. It has long been found of some Bene-
 fit towards the purifying^{te} the Air in Ships, to
 wash and sprinkle them with Vinegar between
 Decks. I wrote the following Proposal to
 Dr. *Martin*, Physician to the late *Lord Cath-*
cart, about two Months before they sailed from
Spithead in the Year 1740; viz. to dip many
 Cloths in Vinegar, and hang them up in all
 proper Vacancies between Decks, whereby
 great Quantities of Vinegar would intermix

and float in the Air. For I had found by Experiment CXVI. Vol. I. p. 266. of my *Statical Essays*, that an Air, which passed thro' Cloths dipped in Vinegar, could be breathed to and fro as long again, as the like Quantity of Air, which was not impregnated with Vinegar: so that Vinegar used in such plenty between Decks, might a little refresh the Air; yet where the Stench is great, it can be but of little Benefit, and that only for a short time.

56. VINEGAR has been long looked upon as Antipestilential, whence it is probable, that there may be a Ferment, between this Acid, and the too alkaline rancid Air, which may thereby be reduced, in some degree, from its alkaline, to a neutral, more wholesome State; for many alkaline and acid Mixtures produce Neutrals. It seems therefore probable, that if Cloths dipped thus in Vinegar were hung up in the Chambers of some sick Persons, or if Air were drawn, or made to pass thro' Cloths dipped in Vinegar, it might be of service to the Sick. But tho' Vinegar may be of some Benefit in curing in some degree the ill Quality of such close rancid Air in Ships; yet it will still be surcharged with Vapours, which will very much incommode and disorder our breathing.

57. FOR, as Dr. *Hoadley* observes, “ Respi-
“ ration is best carried on, when the Air we
“ breathe is perfectly elastick, and cooler than
“ the Vapours in the Lungs; in which state
“ the warm Vapours in the lower parts of
“ the Lungs, ascend up through the cooler,
“ purer, fresh inspired Air: the oftner there-
“ fore we breathe the same Air to and fro, it
“ will not only be more and more loaden with
“ Vapours, which we find by Experience de-
“ stroy its Elasticity; but it will also come
“ nearer and nearer to the same degree of
“ Warmth with the Air in the Lungs, and
“ consequently will lose more and more of
“ those Properties, Coolness and Elasticity,
“ upon which the Circulation of the Air in
“ the Lungs depends, and by which the Air
“ is perpetually changing in ordinary Respi-
“ ration. There must therefore, in a close Air
“ be a Time after which the Air in the vesti-
“ cular Cavities of the Lungs can be no more
“ exchanged for the Air that is new drawn
“ into the Lungs; they being both, near equally
“ hot, and equally loaden with Vapours.” So
that nothing but a thorough ventilating Air can
be an effectual Cure. See Part II.

58. AND for the same Reasons, hot close
Rooms in private Houses, which many are
too

VENTILATORS. 41

too fond of, are not so agreeable to breathe in, nor so wholesome, as Rooms that have a due Proportion of fresh Air admitted into them; beside, such warm close Air tends much to relax the Body. It is the Advice of *Celsus*, an eminent Physician, to have large Rooms for those that are sick of a Fever, or else to have a small Fire in the Chimney, thereby to draw off the bad Air.

59. I HAVE observed the Air to be very disagreeable in the Churches of some populous Parishes, in which there are frequent numerous Congregations. Now the Air in such Churches might easily be made fresher and more agreeable, if in the upper part of the outward Doors a free Entrance were made for the Air, thro' branched flourished Iron-work, instead of close Pannels: Then by setting open the inward Skreen-doors, when there is no Congregation, the outward Air would have a free Admittance, without the Inconveniences that would arise from leaving Windows open in all Weathers: And by the same Means the great Dampness, which is in some Country-Churches, might be prevented.

60. I HAVE been the more particular in explaining the Manner, how such bad Airs produce their pernicious Effects, to evince of
how

how great Importance it is, for us to use our best Endeavours to avoid them. And I make no doubt but when due trial shall have been made, that these Ventilators, or Lungs, will be found so useful in Ships, that effectual Care will be taken to find room for them; and that they will not be looked on as cumbersome, but very valuable Furniture, which will supply them with fresh Air, in such proportion as shall be found most commodious; they being most simple and conform to Nature's own Method of working.

61. AND as to *Goals* and *Work-houses*, when they have full Leisure, the Exercise and Benefit of fresh Air to refresh and cheer them, will, I doubt not, induce them cheerfully to work these artificial Lungs.

62. BUT in *Hospitals*, where also fresh Air would be of great Importance, they must be used with Caution so as not to incommode the Sick.

63. BUT whatever Method is used to ventilate Ships, Goals, Hospitals or Work-houses with fresh Air, in order to make it more effectual, it is absolutely necessary to use all Methods of Cleanliness by frequent Washings, &c. And notwithstanding all these Means, there must needs be some degree of Frowziness, where many Persons are inclosed in a small Compass: but it will be much the more healthy, on account of fresh Air and Cleanliness.

(VI.)

64. **T**HE thus ventilating of Ships will be a probable Means, to prevent in a great measure, those infectious pestilential Distempers, which are too often occasioned by the bad Air in Ships, as also in Goals. When this happens, a very likely Means to cure Ships of the Infection would be to fume them well with burning Brimstone, shutting all the Port-Holes, and covering with Tarpaulins all the Hatch-ways, Gang-ways, and Gratings of the upper Deck. And this may be done with great Safety to the Ship, by placing, according to the size of the Ship, one or more metalline Pots on the Ballast in the Hold, each of them having some Wood-Ashes or Sand, and four or five Pounds of Brimstone, fired by a hot Iron Bullet; taking care that no combustible Matter be within two Yards of the burning Brimstone, either above or side-ways. Any one that is doubtful may soon be satisfied, that there will be no Danger of firing the Ship by this means, if they please to try the thing first at Land, to see how far the Scorch of such a Quantity of burning Brimstone reaches. I need not caution that every Person must be above Deck while

while this is doing, for the burning Fumes will mount with great Velocity and Acrimony up between Decks, and will destroy all living Creatures there, as Rats, Bugs, and other Insects. When the Fumigation has been over for some time, the Coverings must be taken off the Hatch-ways, &c. and the Port-Holes opened, to air the Ship; for which Reason it will be best to do this, not in a Calm, but when there is some Degree of Wind.

65. Mr. *Holland*, the Master Ship-Wright of *Woolwich*, informed me, that he was once concerned in fuming a very infectious Ship, in which many hundreds had died in a short time, with eight Buckets of Tar at once, which gave a strong Fume, with hot Logger-heads, that is, large Bullets with long Iron Handles to them. But as the Fumes of burning Brimstone are much more acid than those of Tar, so they are more likely to cure pestilential Infections, which are with good Reason thought by Physicians to be highly alkaline.

66. I HAVE known several Instances, where after Persons have well recovered from the Small-pox, the Houses have been fumed, the Feather-beds being first lain hollow, on Chairs turned down: And some of the Blankets being

VENTILATORS. 45

ing nailed before the Chimneys, to prevent the Fumes escaping, and the rest of them being nailed unfolded against the Walls, and all Drawers and Boxes set open : Then four or more Pounds of Brimstone being laid on Wood-Ashes, (which give no ill Scent) in an Iron Pot or Pots, according to the size of the House ; and placed on some Sand or Earth in the midst of the lowest Floor : the Brimstone was fired by a hot Bullet, or other large Piece of Iron laid on it. After the Houses were thus fumed, those Persons who left the Houses, for fear of Infection, have with safety returned.

67. THE acid Fumes or Spirit of burning Brimstone, seem therefore effectually to stop the malignant Ferment of the infectious Matter, that was in the Furniture, Walls, &c. of the Houses, which by a Ventilation of fresh Air would require a long time to cure.

68. BUT the Remains of this Fumigation will not be so offensive afterwards, if the House be fumed by means of a large Iron Pipe, or Tube of five or six Inches Diameter ; which standing without Doors on a proper Stove, with Brimstone and Charcoal burning together ; the Fumes are conveyed up the Tube in at a Window ; in which way several Houses in *London* and the Country have been fumed

for

for Bugs; neither is there in this Method the least Danger of firing a House.

69. AND as to the Infection of the Plague, it is probable, it might be of service, if a Ship with infected Goods were first fumed with burning Brimstone: And then when the Bale or other Goods were taken out of the Ship, to have them unfolded in a large Warehouse, where they could be hung up unfolded to their full length; the Warehouse being all the time fumed incessantly with burning Brimstone, to such a degree as the Men employed could well bear: These Fumes might probably prevent the ill Effects of the Infection which lay in the Folds, and which could not be come at when the Goods were fumed in the Ship. And when the Warehouse was full of the hung-up Goods, then it would be advisable to give them a much stronger Fumigation, the more effectually to cure the Infection. This is what is done, as I am informed, by Men who have performed a Quarantine, they being then lain with their Mouths downwards in a Room, and then fumed with Brimstone. See Part II. Numb. 286 to 291.

70. IT were easy to destroy Vermin when they infest a Neighbourhood, such as Badgers, &c. by providing a good Quantity of Tow dipped

VENTILATORS. 47

dipped in melted Brimstone, which being fastened by a *With* to a long Pole, wherewith to convey it, when fired, as far as may be into the Badger's Hole; the Mouth of the Hole or Holes being immediately closed up; this will probably smother any living Creature there.

A Description of the SMALL VENTILATORS, and their Uses.

(VII.)

71. **A**S I was standing in the *Captain*, with Sir *Jacob Ackworth* the Surveyor of the Navy, on the Gun-Deck over the Bread-room, considering how to ventilate the Bread-room with fresh Air; there happening to stand by me a Carpenter's Chest with Tools, it occurred to me, that it might be done by a small moveable Ventilator about the size of that Chest. And accordingly I made a Ventilator at Home of the following Size and Figure, *viz.* Its Length from C to E, *Fig. 6.* was four Feet, its Breadth A C sixteen Inches, its Depth A F thirteen Inches, all in the Clear within. The Midriff was fixed in the same manner with those in the larger ones, and was moved

moved up and down by the wooden Handle M fixed in a square Hole, to the top of the Iron Rod R Z; which Rod had a Rivet-joint at its lower end near the Midriff. See Part II. Numb. 522, 523.

72. IT is best to scribe the end A F of the Ventilator circularly, with the Midriff itself, when fixed in its Place with Hinges, because then it will describe the true Curve-line that it moves in; which will otherwise not be so true, as I have found by Experience, because the position of the Hinges prevents its scribing a true circular Curve.

73. THE Holes of the Valves 1. 2. at which the Air enters, were four Inches square; the Valves themselves were five Inches; which will make little Noise when double lifted, as the Valves of the great Ventilators were. The Air rushed out at two other like Valves, into the Nose B X thro' the Hole X. There was a like Hole at the Bottom of this Nose, which was a Foot long, and another at the Side: which three Holes had all Sliders to them, to open or shut either of them at pleasure. Tho' the Midriff is worked up and down with Ease, yet it is best for two to change Hands often, which will make it very easy to them.

74. THE

VENTILATORS. 49

74. THE Midriff rising and falling a Foot, will convey at each Stroke two Cubick Feet of Air; two Thirds of a Cubick Foot being allowed for what Air escapes at each Stroke, between the Sides of the Ventilator, and the Edges of the Midriff: The Midriff was planed rounding on all its Edges, to prevent its pinching any where. At the Rate therefore of an Hundred Strokes in a Minute, which may be done with Ease, this Ventilator will convey three Hundred Tuns of Air in an Hour: And may therefore be very useful in preserving the Bread in the Bread-room sweet and dry.

75. FOR which Purpose, a Pair of them were made to be used in the *Captain*, which being placed on the Gun-deck, over the fore-part of the Bread-room, Air was conveyed thence, by a square wooden Trunk, which passed through a Hole cut in the Deck, down within a Foot of the Bottom of the Bread-room; and the Air ascended, thro' the After-skuttle of the Bread-room. And in order to try the Efficacy of this Instrument, in the Presence of the Master Shipwrights, and other Officers of *Woolwich* and *Deptford* Yards, who were then summoned to pass their Judgment on the Ventilators; the Bread-room was

E filled

filled with the Fumes of smoaking Tar, which was in a great measure blown out by these Ventilators, in three Quarters of an Hour's working them; and in an Hour's blowing, the Room was quite cleared of the Fumes.

76. AND in the same Manner, the Bread may be kept perfectly dry and sweet, by blowing in fresh Air now and then, as Experience shall show needful, for an Hour in the midst of dry Days, when the Port-holes can be opened; so as to have fresh Air between Decks; otherwise it were better, to have the Air conveyed by a Trunk reaching from the Nose of the Ventilators to the nearest Port-hole, in order to prevent the driving in among the Bread the offensive Fumes, which are between Decks, especially when the Ports are shut: These Fumes being, as I am informed, hurtful to the Bread, it being observed that the Bread does not keep so well, in Ships where there are many Men, as where there are few.

77. THESE small Ventilators will also be of use to keep the Powder in the Powder-room dry; for a stagnant Air, especially when damp, is well known to damage Powder: And some Degree of Dampness, notwithstanding the utmost Precaution, will arise, if there were no other

VENTILATORS. 51

other Cause, even from the sappy Vapour of the Wood of which the Room is made, especially in new Ships. See Part II.

78. THEY will also be of excellent use, to purify most easily, and effectually, the bad Air of a Ship's Well, when there is Occasion to go down into it, by blowing Air through a Trunk, reaching within a Yard of the Bottom of the Well, both for some time before, and during their stay there : This will be a much easier and more effectual Way, than the present Method of letting in Water and pumping it up : yet several are frequently suffocated there, notwithstanding this Method ; for as the Eye cannot discern a suffocating from an unsuffocating Air, so many rush into instantaneous Death, thinking there is no Danger where they see none. Now driving out all the bad Air by good Air, will be an effectual Remedy ; but however, for greater Security, it will be adviseable to let down a lighted Candle first, for that Air is always dangerous to animal Life, which will extinguish a Candle.

(VIII.)

79. **B**EFORE I thought of this safe and easy Method of doing it, I had proposed to make use of the following Instrument,

ment, *viz.* Fig. 7. X Z a Piece of light Alder or Willow, a Foot long from X to Z, and two Inches and a half thick, both in Breadth and Depth, with a Hole K, L, Q, U, five Eighths of an Inch in Diameter, bored thro' it; and at C E short Foffets with like Holes bored through them; to which Foffets, hollow Reed-Canes are to be fixed, by means of short supple Leathern Pipes, so that they are flexible at these Joints. O N, and T S, are square Holes two Inches deep, and an Inch and three Quarters wide, with their sole Leather Covers F G, and H I, nailed over them. I N, is a broad Leathern Valve moving on Joints at I, so as to open by the Force of the Air which passes down the Pipe B, K, L, when Breath is drawn in by the Mouth at the Foffet E, which stands five Eighths of an Inch above G H. G S is another like Valve, which shuts the Hole at Q close, while the Breath is drawing in at E; but when, on the contrary, the Person breathes out at E, then the Valve I N closes the Hole L; and the other Valve G S opens for the Breath to pass freely off through the Pipe V A, by which means, the Person always draws in fresh Air. At O and T are two stiff Wires fixed, to prevent the Valves opening so far, that the Force

V E N T I L A T O R S. 53

of the Breath, which is but small, could not shut them; to do which, it is adviseable to breathe with some little Force. This Instrument is to be fixed to the Mouth by a Tape or Cord tied round the Head; and it will be convenient to have Cushions at the Corners C and D, for the Cheeks to bear off a part of the Pressure of the Ligature from the Mouth.

80. I BREATHED thro' this *Respirator* for a Quarter of an Hour, with great Ease, when the Reed-canes fixed to it, were four and a half Feet long. By means of this Instrument, a Man might go with great Safety into the most noxious Air of a Ship's Well, his Nose being stopped with Cotton or Linen. But I found on proposing the Thing, that the Sailors would rather run the Hazard of Suffocation than make use of it: However, as this Instrument may be of use in some noxious Trades, and other Cases where it may be requisite to go into a suffocating Air, I have here given a Description of it.

81. THIS instrument might perhaps be of use, if there were four or five Feet depth of Water in a Ship; for by the Help of it, a Man might continue under Water that Depth, for a considerable Time, to rectify any thing amiss

at the Bottom of the Well, or to stop a Leak that could be come at in the Hold.

82. I KNOW not to what Depth under Water a Man can breathe with this *Respirator*; 'tis to be feared but a small Depth, because the Weight of Water on his Belly will press so hard on his Midriff, as to hinder his drawing in Breath: unless it shall be found on trial, that he can fetch short Breaths, by the Dilatation and Contraction of the rising and falling Ribs; but then, that must be with a sufficient Force to shut the Valves. If a Man could thus breathe at six or eight Feet under Water, then if a small leaky Ship were put so far on the Careen, as to have its Keel but six or eight Feet under the Surface of the Water, a Man might, by means of this *Respirator*, go down to the Keel, by an under-girding Rope, and there search for and stop Leakages. But if on trial it shall be found, that a Man cannot thus go deep enough; yet he might perhaps go deep enough for Ships, in some degree on the Careen, by means of a Copper Coat of Mail or Armour to cover the Trunk of his Body up to the Arm-Pits, that the Arms may be at liberty: by thus keeping the Pressure of the Water from the Belly, it has been found to do at twelve or fifteen Feet Depth. These

Things I mention, hoping, that at least they may be Hints, for farther Improvements in so very important a Case, as well deserves the most diligent Researches.

(IX.)

§3. **I** CANNOT dismiss this Subject, without saying something in behalf of those, who cannot speak for themselves: I mean young tender Infants; who are often swathed up in such a manner, as must needs greatly incommode their Breathing, and consequently be often very hurtful to them. For when their tender Bodies are close confined in Swathings, neither their Breast nor Belly can rise so freely, as they ought to do, when the Child draws in its Breath: And consequently, not only its Breathing, but Digestion also are thereby greatly incommoded; for the Digestion is much promoted, by the Kneadings of the Midriff on the Stomach, which are no less than twelve hundred in an Hour: And in proportion as the Degree and Force of these numerous Kneadings are abated by Swathings, so will the Digestion be accordingly retarded and incommoded; the ill Consequences of which, to the poor Child's Health, few Nurses are aware of. Those of them who will not

be persuaded to leave off that old very bad Practice, ought themselves to be well swathed up, to be made duly sensible of the Misery they would suffer thereby in one Night.

84. THERE is another very bad Practice in relation to Infants, the ill Consequences of which, few Nurfes seem to be aware of, *viz.* It is well known that for very important Reasons, the Skulls of new-born Children are not in all Parts turned to Bone. But ignorant Nurfes taking the soft Part of the Skull for a great Defect in Nature, are apt, too often, to attempt to close the Mold of the Head, as they call it: that is, to compress together, by stroking and Bandage, those Parts of the Skull which are bony, expecting thereby to unite those distant bony Parts together; not knowing that the intermediate soft Parts will turn to Bone; and little thinking what Injury they do thereby to the tender Infants, by thus compressing their Brains, and thereby causing convulsive Fits, and perhaps sometimes a great Tendency to Head-aches during their whole Lives, &c. Whereas, if they would but let Nature alone to do her own Work, the Head would have its natural Shape, and the whole Skull would of itself turn to Bone: And this
without

VENTILATORS. 57

without compressing the Brain, which is often attended with ill Consequences.

(X.)

85. **A**S Experiments often give Hints for new Experiments, and farther useful Discoveries, so the attempting to convey great Quantities of Air, by means of the above described large Ventilators, has led to a Discovery, which will be of great service to the World, in preserving Corn in Granaries, and Ships, sweet and dry, by which vast Quantities of Corn are yearly spoiled and destroyed all over the World: I am credibly informed by a *Spanish* Merchant, that not less than 80,000 Pounds worth of Corn was spoiled in exporting in one Year, about eight or nine Years ago.

86. **T**HAT I might be assured that Air could be conveyed up thro' great Depths of Corn, I took a wooden Tube or Trunk, which was five Feet four Inches long, and near three Inches square within side; and having nailed a Piece of thin Copper-plate, full of small Holes at the Bottom of it, I filled it full of Wheat; then having fixed to the Bottom of the Trunk, by means of a short Piece of Leathern Pipe, lined with a Bladder, the Nose of
the

the Kitchen Bellows; on blowing at a common moderate rate, the Air passed up through that depth of Wheat, with a Force sufficient to raise Paper and to blow off Leaf-tinsel. I repeated the same Experiment in another like wooden Trunk, which was nine and a half Feet long, where the Air, in ascending up through the Corn, raised the Tinsel also, though not so forcibly as in the shorter Trunk, because it met with more Resistance, in passing through a greater depth of Corn; which therefore required proportionably larger Bellows, and a greater Force: for these Bellows contained but seven Half-pints of uncompressed Air; as I found by blowing the whole Air which they contained, through a leaden Siphon fixed to the Nose, up into an inverted Glass Receiver full of Water.

87. IN order to find the Quantity of Space there is between the Grains of Wheat, for Air to pass through, I poised a Quart Pot in a Pair of Scales, then filling it full of Water, I took the Weight of that Water. Then, the Pot being emptied and wiped dry, I filled it, strike Measure, full of Wheat, first shaking it well; and having taken the Weight of the Wheat, Water was poured in among the Wheat till it was brim-full; when being weighed

VENTILATORS. 59

weighed again, and the additional Weight of Water, among the Wheat, being deducted from the Pot full of Water only, it was found to be one-seventh, and three-tenths of the Quart of Water; therefore the Sum of the Space for Air to pass through Wheat is $\frac{1}{7.3}$ of the Bulk of any Quantity of Wheat: A sufficient Space for Air to pass through it in good plenty.

88. THE Capacity of the Pot being 88.6 Cubic Inches, of which 12.1 Cubic Inches being the Sum of the vacant Space among the Wheat, therefore the remaining 76.5 Cubic Inches is the Space occupied by the Wheat; whence by comparing the respective Weights of the Wheat and Water, I found Wheat to be nearly one-tenth heavier than Water.

89. AND the Air passed as freely thro' a like Depth of Oats, as it did thro' Wheat, and more freely thro' Barley, and still more freely thro' Pease and Beans; between which last mentioned Grains there were, on account of their different Shape, larger Interstices for the Air to pass, than between the Grains of Wheat and Oats; and this, whether there were at the Bottom of the Trunks a thin metalline Plate full of Holes, or a Hair-cloth: So that the Floors of Granaries may be covered with either

ther of them. But the fuller of small Holes the Iron Plates are, so much the better. But Iron Plate will cost about Twelve-pence a square Foot ; Hair-cloth not Two-pence, which is more than six times cheaper : but then Iron Plates would be more durable ; and will prevent Rats and Mice from coming at the Corn, by Holes through the Floor ; and are therefore preferable, especially in large Granaries : They would also better bear the Fumes of burning Brimstone, than Hair-cloth, when they were to be blown up through the Corn, in order to destroy Weevils ; but if the Brimstone Fumes be conveyed to the Valves of the Ventilators by a wooden Trunk, lined a little way with Tin, then at such a distance they will not damage the Hair-cloth, especially considering that the Fumigation need be but rarely repeated. And it is found by Experience, that a Hair-cloth will endure the constant Heat of a Malt-kiln for many Years, without being spoiled thereby.

90. Now in order to find with what Force the Air was impelled by the Kitchen Bellows up through the Corn in the Tube A B, *Fig. 9.* I fixed an inverted glass Siphon C R I into the Side of the square wooden Trunk full of Wheat, which was nine and a half Feet high.

When

VENTILATORS. 61

When the Siphon was fixt half a Foot from the Bottom, the Mercury, by the Pressure of the Air among the Wheat, descended half an Inch below C to R, and ascended half an Inch above I; so that it stood an Inch higher in the Leg I than in the Leg R; which showed that the Air among that part of the Wheat, was impelled with a Force equal to the Weight of an Inch depth of Mercury, which is nearly equal to fourteen Inches depth of Water. When the Bellows were compressed very forcibly, then the Mercury would by Vibrations rise three and a half Inches. When the Siphon was fixed at three Feet from the Bottom, then the Water instead of Mercury in the Siphon was raised about two Inches, which was one-seventh of the former Force. When it was fixed five Feet from the Bottom, the Water was raised about an Inch; and at the distance of eight and a half Feet from the Bottom, it was raised half an Inch; hence we see the different Degrees of Compressure of the Air at these several Depths, in the Wheat. Not that the Velocities of the Air through it, were proportional to the several Pressures of it. For the greater Compressure of it near the Bottom, was owing to the greater Resistance it met with, from the great Height of the Wheat

it

it was to pass through, which must considerably rebate its Force as it ascended higher; but when it had a less Height of Wheat to pass through, the nearer it came to the Top, tho' the Force with which the Air was there impelled was much rebated, yet the Velocity of its Ascent was increased: for when the same Experiment was repeated with Pease in the Trunk instead of Wheat; the Air having a much freer Passage through them, ascended with greater Velocity, notwithstanding the Compressure of it, and consequently the impelling Force was not in any part near so great as in the Wheat.

91. Now hence, some Estimate may be made of the Force, which will be needful to drive Air up through Corn in Granaries; and as the Force with these Corn Ventilators is greater, and the Quantity of Air which will be requisite much less than the Quantity of Air and Velocity with which it is impelled, by the above described large Ventilators; so they may be much less, for the use of Granaries and Corn-ships, which will proportionably lessen the Labour of working them: But on the other hand, Care must be taken that they be not too small, but proportioned to the Size of the Granary; which will be best known by Experience.

VENTILATORS. 63

92. THE Air passed through these several kinds of Corn, in the Trunk of nine and a half Feet depth, not only when the Corn lay more loose at first putting in; but also when by striking often, on all parts of the Trunk, with a Hammer, it lay the closer, though it did not, after this, pass altogether so freely, because it lying closer, the vacant Interstices between the Grains of Corn were the less: but all sorts of Corn must necessarily, by reason of their Shape, have vacant Interstices between them, for the Air to pass through.

Nine and a half Feet depth of Wheat, sunk

on shaking $4\frac{1}{2}$ Inches, viz. — $\frac{1}{24.4^{\text{th}}}$

Barley, — — — — — $\frac{1}{10.2}$

Oats, — — — — — $\frac{1}{5.5^{\text{th}}}$

Grey Pease, — — — — — $\frac{1}{12.8^{\text{th}}}$

Hence we see the great difference there is in the Quantities of a Bushel full of Corn, when unshaken or shaken.

93. IT is reasonable to believe, that the Benefits of this Method of preserving Corn, will be many and great; it will not only preserve Corn dry and sweet, and prevent the giving or flaking of Malt, which it is apt to do in lying long; but will also prevent the Increase of Weevils: for the heating of Corn, is observed

served much to promote their Increase; tho' when the Corn is kept very close, as is sometimes purposely done in Ships, the great Heat and Smother will destroy them. See more, Part II. 471, &c.

(XI.)

94. **I**T is usual for Millers to wash smutty Wheat clean, and afterwards to dry it on a Kiln, in twelve or fourteen Hours, turning it; but then this Kiln-drying often makes it grind unkindly, and not make good Meal: Whereas, after Corn is thus washed, and it has drained off, for some time, the Gross of its Wet on a Hair-cloth laid on Hurdles; if it were afterwards dried by the Ventilation, it would then grind as well as other Corn; for drying Wheat with cold Air would not hurt it, as Kiln-drying is found to do. And that I might be well assured of the good Effect of thus drying smutty Corn, having procured a Quantity of very smutty Wheat, which weighed seven Pounds and fifteen Ounces; *May* the 26th, at five in the Morning it was washed clean, in four several Waters, which was done in a few Minutes, and was then lain to drain in an Oat-sieve, till Half an Hour after Five, when it had increased in Weight by wetting,

ten

VENTILATORS. 65

ten Ounces, besides the Moisture that was equal to the Weight of the Smut-balls and Smut, that was washed from the Wheat: It wasted but two Ounces and a half by the first two Hours Ventilation, two Ounces and five Drachms in the second two Hours, *viz.* from eight to ten; in the next six Hours, *viz.* from ten to four in the Afternoon, it wasted at the rate of four Ounces, each two Hours; from four to six, two Ounces and a half; and from six to eight one Ounce and a half, in all about twenty Ounces, some Allowance being made for what Corn was wasted, by handling and biting some of it from time to time. It was ventilated in these fourteen Hours with about forty thousand Gallons of Air, which passed upwards through it, and made it sufficiently hard and dry, so as to be fit for grinding; it was well coloured, and handled well, and from stinking, as smutty Wheat does, it became much sweeter. The visible dewy Moisture was blown off in three Hours, but it continued damp and cold to the Feeling, till Two o'Clock, when some little Dust began to fly off it.

95. AND whereas it wasted off much lesser Moisture, during the four first Hours Ventilation, when it ought to have wasted the more, on account of its being then wettest, this was

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owing

owing to the foggy Haziness of the Morning ; which as it went off and broke out into fine warm Sun-shine towards Ten o'Clock, so the Air being thereby become dry, it imbibed Moisture more strongly from the Corn. And that this was the true Cause of the Difference, is further confirmed, by a like Experiment, which I had before made on a Gallon of Wheat, *April* the 1st, there being then a very dry North-East Wind : Beginning the Ventilation at Four in the Afternoon, it wasted in two Hours four Ounces and a half ; and the next two Hours, being towards Evening, but three Ounces ; and the next Morning early, before the Air was freed from the nocturnal Damps, only one Ounce and a half.

96. It will be adviseable to begin to ventilate Corn as soon as possible after washing, that the Moisture may have the less time to soak in ; for the less the Moisture soaks in, so much the sooner the Corn will dry. The inner Part of this Wheat was manifestly the softer for wetting.

(XII.)

97. **T**HE first large Ventilators which I made, for drying great Quantities of Corn, were at Mr. *William Knight's* of
Street-

VENTILATORS. 67

Street-House in *Farringdon*. The Midriff rested on its lower Edge, in a Groove which was formed by two Fillets nailed to the Bottom of the Ventilators. In this Position, the Midriff, which was seven Feet long, and three Feet four Inches broad, was moved to and fro, sixteen Inches sideways, that being the Depth of the Ventilators, which were fixed in an upright Posture breadthwise, to the Side of a Garner, which was six Feet five Inches long, and four Feet four Inches broad, in all twenty-eight square Feet. The Laths, which were placed on their Edges lengthwise, under the Hair-cloth, which covered the Bottom of the Garner, were two Inches deep, and two Inches distant from each other: They were all supplied with Air, from the large common Air-trunk which was fixed at one End of them: which Trunk was supplied with Plenty of Air, from the Valves at one end of the Ventilators, VV, *Fig. 10.* the Air being conducted thence, by a Trunk or Box; the Air entered the Ventilators at their other Ends, by the opening of the like Valves, and not at the Valve Z.

98. The Midriff was moved to and fro by a Lever, which was fixed to its Iron Tongue ST, *Fig. 10.* and stood upright, its lower

End being fastened to the Floor, that being the most commodious Position for it in that Place.

99. WHEN Corn was laid in this Garner, above two Feet deep, the Air was driven upwards thro' it by the Ventilators, so as to raise a Handkerchief which was spread on it, three or four Inches high, and that all over the Corn: But as the Force of the Air thro' the Corn, was something more at that End of the Garner where it entered; so the Corn was laid thickest there.

(XIII.)

100. **J**ULY 13th, Twenty-two Bushels of very smutty Wheat were washed; in doing of which, when the Corn is poured gently in a thin Stream on the Water, the Smut-Balls having thereby Liberty to extricate themselves from the Wheat, swim on the Water, where they are easily scummed off; then the Wheat being well stirred, and the foul Water let out, fresh Water is poured in, by which means it was soon cleansed. And then, being lain for some time on a Hair-cloth on Hurdles or Harrows, for the Water to drain off, it was put into the Garner, where it lay about 16 and $\frac{1}{2}$ Inches deep.

101. AT

VENTILATORS. 69

101. AT Nine in the Morning, the Weather being cloudy, with a dry North-East Wind, we began to blow Air up thro' it, which passed very freely. In two Hours the visible Moisture was gone, it being partly soaked into the Corn, and partly blown off. The next Day about Six in the Evening, it being clear Sun-shine, with a dry Wind, the Dust flew out of the Corn when stirred.

102. THE third Day, about Three in the Afternoon, the lower Part being hard enough to grind, it was turned. After this, some rainy Days coming, which made the Air within Doors so moist, as to cause a great Dampness on the Flint-Stone Walls within the House, no Progress was made in drying the Wheat, not even by long Ventilation; which I was assured of, by putting four Pounds of Wheat into a Hair-Sieve, which was placed on the Wheat, where the Air passed freely up thro' it. Hence by weighing this Sieve from time to time, I found what progress was made in drying the Wheat, in different States of the Air, as to Moisture or Driness: For the Corn was found to dry fastest in the middle of dry Days, and something slower when the Dew fell in the Evening, and till it was gone in the Morning: But in a very damp State of the Air,

there was no Progress made in drying. But tho' no Progress is made in drying Corn thus, in a very damp Air; yet there is so large a Proportion of the Times, when the Air is dry enough for the purpose, as to make it well worth the while to be provided with these Ventilators, especially to dry cold Corn, which will be done much sooner than washed Wheat.

103. HAVING ceased to ventilate from *Saturday* Evening to *Monday* Morning, while the Wheat was damp, it was grown musty; which Mustiness was quite gone in three Hours Ventilation, notwithstanding the Air was very damp. Hence we see of how great service this Ventilation will be to sweeten musty Corn. Hence also we may conclude, that even in damp Weather, the Heating and Mustiness of Corn may be prevented, tho' it cannot be then dried by this means.

104. FINDING that the lower Part of the Wheat was dried long before the upper, we took half of it out of the Garner, and then soon dried it, when it was but of half the Thickness, and the Air in a drying State.

105. *Sept. 11th* following, in fine dry Weather six Bushels of smutty Wheat were washed and dried fit to grind, with fifty-eight Hours Ventilation. The Corn thus dried was well coloured,

VENTILATORS. 71

coloured, and sold at the Rate of forty Shillings a Load more than it would have done when smutty.

106. IT was very observable, that the Air passed much more easily in moist Weather thro' the damp Corn, than when it grew drier: For the Ventilators required sensibly more Force to work them when the Air and Corn were dry, than when wet: which was, as I guess, owing to this, *viz.* That the Air and Corn repelled each other more strongly in a dry, than in a moist State; which will have the same Effect, in causing the Air to pass less freely, as if the void Spaces between the Corn were proportionably lessened.

107. HENCE we see one Reason among others, why a dry Air exhilarates and cheers more than a damp Air, *viz.* because a dry Air being in a more strongly repelling State when inspired into the Lungs, it thereby dilating their small Vesicles or Air-bladders more than a damp Air will, does thereby cause a much freer Circulation of the Blood thro' the fine Blood-vessels in the Coats of those Air-bladders: For, that the Blood passes the more freely thro' the Lungs, the more they are dilated, I have shown in the Instance of the sighing Horse; *Statical Essays, Vol. 2. Ex-*

per. 1. This also may be one Cause, why a very dry Air is hurtful to those who are consumptive from weak Lungs; a very dry Air more forcibly dilating the fine Air-Vesicles of the Lungs, than a moister Air will do: And perhaps another Reason may be, that a very dry Air may carry off too much Moisture from some kind of morbid Lungs. For even the most robust and healthy are greatly incommoded in their Respiration, in a very dry Air; insomuch, that on the Eastern Coast of the Red Sea, when the Wind blows from the sandy Desarts of *Arabia*, they are obliged to moisten the Air, by sprinkling Water, and breathing thro' wet Linen. And in the Southern Parts of *France*, where the Air is very pure, when it is also very cold, they apply, by way of Precaution, a Handkerchief to the Mouth, when they go into the open Air, out of a warm Room, lest the sudden Change from hot to cold, should cause Inflammations and pleuritick Disorders, by taking in a full Indraft of cold Air. And *Acosta* says, that the Air on the Tops of some of the *Peruvian* Mountains is so very cold, as at one Inspiration to thicken the Blood.

108. THIS Garner contained but twenty-eight square Feet: If it had been a Square of
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VENTILATORS. 73

ten Feet, as it would then have contained a Hundred square Feet; then a Load of Wheat, which is fifty Cubic Feet and a half, would lie but six Inches deep on it: That Quantity therefore of cold or wet Wheat might well be dried at once in a Garner, or on a Floor of that size. And Corn thus ventilated may be dried to the same degree, as any other dried Corn is, by being exposed in the Ear to a dry Air in the open Field; this sooner or later, in proportion to the different Degree of Driness of the Air.

(XIV.)

109. **M**ILLERS may very commodiously dry washed Corn thus, and may therefore well allow the Farmer the better Price for smutty Wheat; since when it is thus dried by Ventilation, it will be very good, and make good Flour, it not being spoiled by drying on a Kiln, which is the Method they have hitherto been obliged to use. And the more any Corn is thus dried, so much the better its Meal will keep: which is the Reason why they are obliged to kiln-dry the Corn, which is to be ground for Exportation and Ship-service, especially in long Voyages.

110. IN

110. IN Mills, the Ventilators might be worked by a Crank turned by the great Mill-wheel, whereby the Expence of Men's Labour might be saved.

111. THE Quantity of Moisture to be carried off in a Load of washed Wheat, is very considerable : for suppose it were but ten Ounces to a Gallon, as it was found to be in the Gallon of washed smutty Wheat, (Numb. 95.) which yet was more, it would then amount to no less than two hundred Pounds weight.

112. AND the same Ventilators might also be used in Mills to winnow Corn very effectually ; but then they must be larger than when used to blow Air upwards through Corn. For I have found on Comparison, that the above described large Ventilators convey Air with double the Velocity, that the common circulating Fans, with Sack-cloths, do. But where these Fans are in Mills, turned with a greater Velocity, than is done by Hand in Barns, they winnow so much the better.

113. IF so great a Quantity as four Ounces of Moisture can, by two Hours Ventilation, be carried off from a Gallon of wet Wheat ; then this Method will doubtless much improve what is called cold Wheat, *viz.* such as has
grown

VENTILATORS. 75

grown and been housed in a cold wet Season: And will therefore doubtless soon carry off the moist Vapours, which arise from Corn, and cause it to heat and grow musty. And by thus keeping Corn very dry, it will come the fairer to Market, and be much the better for Use.

114. CORN need not be constantly thus ventilated, but only now and then. And when it is become once thoroughly dry, then very little Ventilation will be sufficient.

115. As ventilated Corn may lie thick without leaving any spare Room to turn it, the more Corn may be laid in Granaries already built; and where new ones are to be built, they may be the less.

116. THE Expence of turning Corn will be saved, and the ventilated Corn will be both sweeter and drier than turned Corn can be, by this means even musty Corn may be sweetened.

117. The Expence of Sacks in Ships may be saved, or if the Corn be in Sacks, it will keep sweet, much longer, when the Air between the Sacks is fresh and dry, by the Ventilation of the Ship-lungs; but this, provided the Corn was not damp, when put into the Sacks. This Ventilation will also be of great service to many other kinds of Goods in Ships.

118. SINCE

118. SINCE by this means Corn may be so effectually preserved, with little Trouble or Expence; it will doubtless be a great Encouragement, to lay up large private and public national Stores in plentiful Years, whereby the great Inconveniencies and Miseries which arise from Years of Scarcity, will in a good measure be prevented. And the Price of Corn will not for the future be so subject to great Inequalities, as it has hitherto been.

119. AND this will probably be better both for the Buyer and the Seller: for though in Years of Scarcity, the Farmer will not have so very high a Price for the little Corn he has, as formerly when less Corn was in store; yet he will be made ample amends for that, in selling his great Quantity of Corn, at a much better Price than he used to do, to fill the Store-houses with Corn.

(XV.)

120. **T**HE discovering any Means to preserve the necessary Products of the Earth, should in Reason prove a great Benefit to the World in general; yet I should be sorry to be any ways instrumental, in increasing the Quantity of Corn in the World, if by reason of its greater Cheapness on that account,
 propor-

proportionably greater Quantities of Spirits should be distilled from it, to destroy Mankind. As things now go in the World, there will in a little time be no occasion to use means to increase the Quantity of Corn; since the number of the People who are to eat it, daily decreases, either by the untimely Death of Multitudes, whose Vitals are destroyed, by these hot caustick burning Spirits, or on account of great Numbers, whose Stomachs are thereby so depraved, that they can eat little or nothing, to the great Detriment of the Landed Interest.

121. IF Mankind be thus supinely suffered to be destroyed thereby, he ought in Reason to be looked upon, as doing the best Service to the World, who finds means of decreasing rather than of increasing the Quantity of so destructive a Pest: which is become an inexhaustible Fund of Misery and Ruin to the lower People.

122. IT debilitates and infeeble Multitudes of the Laborious Part of Mankind; and its pernicious Effects will be severely felt in the puny Pigmy-breed of future Generations.

123. BESIDES, the Spirit of Drunkenness, which is now so prevalent among the Dramatists, wholly quenches the Spirit of Religion, and depraves the Morals of Mankind. Info-
much

much that the Reproof of God Almighty to the Prophetesses of old, may but too justly be applied to this Generation, *viz. Will ye pollute me among my People for handfuls of Barley?* Ezek. xiii. 19.

124. THIS is sure, greatly to abuse that large and ample Provision that kind Providence has provided for us: 'Tis turning into Poison that *Bread* which was graciously intended to *strengthen Man's Heart*.

125. AND surely such weighty Reasons ought to rouse the Governors of the Nations, as tender Fathers, to use their utmost Endeavours to deliver the People, committed to their charge, from this mighty Destroyer. Can there be any Considerations of sufficient weight to the contrary? And will not this, in the end, be found the most effectual means to increase the real Wealth and Strength of a Nation? But what need of Expostulation in a self-evident Case, which strikes in so strong and glaring a manner, that not only every open willing Eye, but even the wilfully blind, cannot but see the Miseries it brings on a great Part of Mankind; as is evident to daily and constant Observation and Experience, in thousands of Instances.

(XVI.)

126. **B**UT to return from this important Digression, the following seems a probable means, the better to dry damp Mows or Ricks of Corn, and thereby to prevent their firing, or the Mow burning of Corn, *viz.* When a Well is made in the middle of a Mow of Corn (as is the known Practice) I would propose this farther Improvement, *viz.* about four or five Feet from the Ground, to leave four horizontal Passages, a Foot square, opposite to each other, two of them leading from the Well lengthwise to the Ends of the Mow, and two of them breadthwise to the Sides; and to make Holes through the Boards, at the Sides and Ends of the Barns, for these Passages to communicate with the fresh open Air, which would by this means pass freely through the Corn Mows; and it would also pass most freely up through the Well, if all the Holes are closed, except that at which the Wind enters. Thus, suppose the Wind to blow against the fore part of the Barn, then let the Holes on the opposite Side of the Barn be closed with Shutters which move on Hinges fastened to their upper Side, which Position will prevent the entrance of Rain,

Rain, when the Shutters are open. By this means, the Vapours which steam from the Corn into the Well, will be carried off in a manner, as fast as those which arise from the outfides of Ricks, that stand in the open Air ; whereby the Corn in the middle of the Mow will be dried near as fast, and to as great a depth from the Sides of the Well, as at the outfides.

127. I N order to make trial of this Method, I provided Cradles, made of four Ashen Poles, which were fastened, at a Foot distance from each other, with Ledgers or Rounds, making thereby square oblong Cradles, like four Ladders joined together. The end of the Barn where the Corn lies, being twenty-eight Feet wide each way, and the Well in the middle three Feet across, these Cradles reached from the Well to the End and both Sides of the Barn ; where Holes were made through the outside Boards a Foot and half broad, and two Feet long from Bottom to Top, thereby to make a sufficient allowance for the sinking of the Cradles with the Mow. On which account, the Bottoms of the Cradles must at first be placed even with the upper Parts of the Holes in the outside Boards.

128. THIS

VENTILATORS. 81

128. THIS End of the Barn was filled with Barley, in a wet Season, and lain very wet in the Mow, much wetter than they would otherwise have done, presuming that the Well and Cradles would prevent its getting any Damage. When they threshed this Barley in *November* and *December*, the upper Part of the Mow was in a good Condition, and, though lain in so wet, the Well and Cradles prevented its heating and Mow-burning. But as it was lain in very wet, and did not heat so as to make it sweat off its Moisture, it grew mouldy, so that the Barley-ears were covered with a white Fenn. From the Well in the middle of the Mow, to the Barn-floor, there was lain for Trial-sake, a long Range of Faggots, consisting of three Rows of them, lain on each other: But the Faggots being small, and the Wood straight and even, there was very small Passage for Air; whereas if they had been made of a rougher Wood, there would have been a freer Passage for Air: The event was, that the Corn was matted together and grown, near the Faggots; but about the Cradles it was drier and better, yet this did not reach far.

129. THUS, I have given an account of the Event of this Trial with Cradles, that the skilful Farmers may judge, how far they may,

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or

or may not be of service to them in Mows or Ricks of different Sizes, and different Degrees of Wetness or Driness: For according as these Circumstances vary, they may be more or less beneficial, or even hurtful; for some degree of heating in the Mow is of use to give Warmth enough, to cause the Moisture to go off in a Wreak. It cannot be inferred from this Trial, that these Cradles will be of no service in any Case; for this Barley was so very wet, that without the Cradles it would not only have been in danger of being Mow-burnt, but also of firing. As these Cradles do in effect divide a large Mow into four smaller ones, they will therefore be of use, where the Corn, when first lain in, has such a Degree of Dampness, as would be too much for it, in a large Mow; but would do well in a smaller Mow or Rick, and may also contribute to make Corn, which is lain pretty dry into a Mow or Rick, the drier.

130. I HAVE found on Trial, that undried Gunpowder may be as thoroughly dried, by thus blowing Air up through it, as in the very dangerous hot Fire-stoves of the Powder-makers. For, having found, that Air blown from a common Pair of Kitchen-bellows, would pass very freely up through sixteen
Inches

VENTILATORS. 83

Inches depth of Gunpowder, so as to raise up a Piece of Paper that lay on it; I acquainted Mr. *Norman*, Owner of the Powder-mills at *Moulsey*, near *Hampton-Court*, with this; who sent me his chief Clerk with twelve Pounds of undried Powder; which we put into a Box, where it lay seven Inches deep on a Cheese-cloth, which rested, on a Lacing of Packthread, an Inch and half from the Bottom of the Box.

131. JANUARY the 20th, having fixed in an opposite Position, the Noses of two Pair of Kitchen-bellows, in Holes made thro' the Box, under the Cheese-cloth, Air was blown forcibly up through the Gunpowder, and every two Hours the Box was weighed, to see how much it decreased in weight from time to time. The total Decrease of Weight, by the Evaporation of the Moisture, and flying off of Dust, and of some Grains of the Powder, was, in twenty Hours blowing, one Pound six Ounces. Six Pounds of the like Powder, being dried in the hot Stove at the Powder-mills, decreased in weight five Ounces and a half; hence, nearly half the Waste in this Operation with Bellows, was by the flying off of the Dust, and some of the Grains of the Powder; which Dust will most of it be saved,

in large drying Rooms, made fit for that purpose.

132. Now the Powder thus ventilated was thereby so fully dried, that on Trial with the *Proof* Instrument, it was found to be as strong, as some of the same Powder, just then dried as much as it could be by Fire. And there will be no Danger of spoiling by overheating it, as is sometimes done in Stoves.

133. MARCH 30th following, the Air very dry with an Easterly Wind, I repeated the same Experiment, with twelve Pounds of undried Cannon-powder; which Mr. *Underhill* sent me from his Powder-mills on *Hounslow-Heath*: it was put into a Box of such a Size that it lay 2 and half Inches thick. It wasted in the first two Hours Ventilation near two Ounces: Happening, after an Hour and three Quarters more Ventilation, to stir the Powder with my Fingers to the Bottom, the Dust rose in thick Clouds where I stirred, but not without stirring: It was well dried in six Hours, and tho' it was ventilated on for eight Hours more, yet it did not prove sensibly stronger on Trial, than that which had been ventilated only six Hours. When these thus dried Powders, either after six or fourteen Hours Ventilation, were compared by Mr. *Underhill* and

VENTILATORS. 85

his Clerks, with some of the same Powder dried in his Stove; the latter raised the Proof Instrument to two Degrees, and the former, but to one and three Quarters: the Reason of which Difference, we found on repeated Trials to be this, *viz.* that some of the smaller Powder, being by Ventilation separated from among the larger Grains, its Strength was not so great: For when we tried some of the smaller Powder, it then exceeded the Force of the Stove-powder, it raising the Proof-Instrument two and a half Degrees, which was half a Degree more than it rose with the Stove-powder; so that it may be looked on to be as thoroughly dried as the Stove-dried Powder: It is found by Experience, that, *cæteris paribus*, the smaller the Corn of the Powder is, so much the greater will its Force be.

134. AND since the Dust in this Operation did not rise, unless when stirred, therefore it will be best to avoid stirring the Powder, while it is ventilating: And as to what falls thro' the Canvas, it may be mixed with the Powder, after it is thoroughly ventilated: There was about a Pound of the finer Corns, which were found under the Canvas, having dropped through its Pores.

135. BY comparing this Trial with that which was made in *January*, we may observe, that the different State of the Air, as to Moisture and Driness, has a considerable Influence, in hastening or retarding the drying of the Powder. And I observed the same in drying of Malt and Wheat; that early in the Morning, they did not waste near so much as in Mid-day. But if instead of cold Air, the Powder be ventilated with a hot Air from a Stove, which is heated by a Fire in an Iron *Cockle*, as is done in some Hop-kilns, then the Powder would probably be effectually dried, in an Hour or two, sooner or later, in proportion to the Degree of Heat of the Air; and this, tho' it lay of a great Thickness: And we see in the Case of ventilated Hops, that great Quantities of hot Air may easily be had from a proper Stove. And as it would be dried so soon, it would save a great Expence of Fuel: And would also be done with much Safety from firing; for the hot Air might be conveyed from the Stove, thro' a large square wooden Trunk, to the Place where the Powder is, at any Distance that shall be thought proper. And that the Trunk might not be affected by the Coldness or Moisture of the Weather, it might be covered with another like Trunk of Boards,

at

VENTILATORS. 87

at about an Inch distance from the inner Trunk ; the outer Trunk to be tarred to keep out Moisture. In this Situation, there would be little Danger of firing the Powder, even tho' the Stove should by accident take fire. See more of this Part II. Numb. 561.

136. AND since undried Powder can by this means be dried to such a Degree ; Barrels of Gunpowder which lie in Storehouses and Magazines, especially in damp Countries, may by the same Means, doubtless, be kept very dry : For as the Liquor in Casks wastes considerably by its soaking thro' the Wood, and perspiring away ; so, on the contrary, if Powder-barrels are in a moist Place, the Moisture must needs soak thro' them and damage the Powder. But this may effectually be prevented, if great Quantities of fresh Air be, by means of such large Ventilators, conveyed into Magazines of Powder, in dry Days, and in the driest Part of those Days. And when Powder is kept very dry, it has been found by Experience to retain its Virtue and Force for above fifty Years.

137. AND as the Powder in the Powder-room in Ships, is subject to be damp, so that, as I am credibly informed, in long Voyages, they bring the Barrels of Powder above Deck,

in order to dry them in the Heat of the Day ; and in *English* Ships, they have the Powder-room under the Cook-room ; now it may with the greatest Ease be kept dry in Ships, by conveying fresh Air into the Powder-room, in the middle of dry Days, with the above-mentioned small Ventilators, Numb. 71.

(XVII.)

138. **A**IR is one of the great Instruments of Nature, by the Motion of which, it is not only rendered wholesome, but is thereby also made instrumental in being serviceable to all the Products of the Earth : For it not only, by its Ventilation, carries off the great Quantity of Vapour, which perspires from all kinds of Vegetables, which if left to stagnate around them, would suffocate them and produce Mildews, &c. But it also greatly contributes to the gentle drying of the Substance of growing Vegetables, whereby they are not only enabled to attract vigorously fresh Nourishment, but also grow thereby gradually more and more firm and hard.

139. DR. DESAGULIERS in his Experiments on *Electricity* observes, that a dry Air is very *Electrical*, by which Property it attracts Moisture strongly : Thus a Glass Tube excited to
Electri-

VENTILATORS. 89

Electricity by rubbing, will not only forcibly attract little Drops of Water to it, but will also draw a small Stream of falling Water of $\frac{1}{16}$ th Inch Diameter from a Perpendicular to a Curve. No wonder then, that Air in passing up through Gunpowder, for a Continuance, should dry it so perfectly well.

140. HAVING therefore found means to put great Quantities of Air in Motion, with Ease; we may doubtless, in Imitation of Nature, make it beneficial to us in many Respects. Thus it might be of use in several Trades, to carry off the noxious Vapours of the Materials which they are working upon, by a large Stream of fresh Air.

141. THEY may also be of considerable Use to publick Brewers in hot calm Weather; when, as I am informed, whole Brewings of Beer are sometimes spoiled for want of Motion in the Air, to carry off the Wreak, which not only damages it, by dropping down again into the Wort in the Coolers, but also retards its cooling; and by being thus kept too long warm, makes it work unkindly in the Tun.

142. I HAVE been informed by an Upholder, that large Stores of Feathers are very apt to spoil, for want of fresh Air; which Inconvenience, this Ventilation would not only effectually

fectually prevent, but would also make the Feathers much lighter and softer for use.

143. THE Ventilation of fresh Air contributes also much to the preserving Woollen Goods free from Moths, and would therefore preserve Wooll in Stores.

144. THESE Ventilators will also be of service to ventilate large Rooms with fresh Air, in hot Climates, and that more effectually, and with less Labour, than it is at present done with large Fans. And such Ventilation is refreshing, even tho' the ventilating Air, which surrounds the Persons, be as hot as before any Ventilation was made; for Breezes refresh in hot Climates, *viz.* because thereby the frowzy Vapours, which exhaled from those Persons, being carried off, a freer Perspiration is thereby promoted, which refreshes and exhilarates. And for the same Reason, it is of good service to the Sick in Hospitals and private Chambers, to have their frowzy rancid Air, (which incommodes the Sick more than many are aware of) exchanged for dry, pure, warm Air.

(XVIII.)

145. **I**N order to try of what use these Ventilators would be in drying Hops; I
went

VENTILATORS. 91

went to Sir *Thomas Hales's* at *Howletts* near *Canterbury*, where there are four adjoining Kilns in one Building, which have Cockles of cast Iron fixed in the middle of them. They stand on Brick-work about thirty Inches from the Ground, and are two Feet four Inches high; two Feet nine Inches broad in Front, and two Feet eleven Inches long backward; with a lesser Iron Box, which covers a Hole on the Top behind; which Box is two Feet three Inches long in Front, ten Inches broad and deep: At the Back of this upper Box, is a large Hole thro' which the Smoke is conveyed by Brick Funnel, quite round the upper Part of the Kilns, and thence passes off thro' an upright Chimney; by which means the Smoke of the *Newcastle* Coal, which is the Fuel, cannot damage the Hops. The Distance of the upper Surface of the Cockle from the Hair-cloth, on which the Hops lie, is six Feet seven Inches.

146. To the Outside of a Kiln, I fixed a Pair of Ventilators, in an upright Posture; which are here described in *Fig. (10.)* I, K, O, O, M, N. They were made eight Feet long in the Clear within-side, from A to C; four Feet seven Inches high from A to P; their Depth within from C to D, was sixteen and a

half Inches; so that there was room for the upper Part of the Midriff to move to and fro sixteen Inches; an Allowance being made of half an Inch, for the Thickness of the Midriff, which was made of Deal-boards half-inch thick, laid length-wise from C to A, and fastened together with broad Battings, which at each End were half-inch thick, but that in the Middle was an Inch thick, for greater Strength; the Iron Tongue S T being here screwed fast to it, about eight Inches from the Top, with an Iron Plate on each Side; it had a Joint at the Midriff every way moveable, that thereby it might the better comply, both with the Motion of the Midriff, and also of the Lever G F, to which it was fixed by an Iron Pin, in a Mortice at T. The Length of the Lever, which was fixed at G with a moveable Joint, was three Feet long from G to T, and eight Feet six Inches from T to F, the End which was worked to and fro by Mens Hands, in a horizontal Posture; a small Wheel of four Inches Diameter being fixed to it at R, that it might move the more easily on the Board X X, which it rested on: There were also at X X, Checks to stop the Lever, at its utmost Vibrations, thereby to prevent the
breaking

VENTILATORS. 93

breaking the Ventilators in working the Midriff to and fro.

147. THE Midriff standing thus edgewise, had no need of Hinges, but rested in a Groove, which was formed by Fillets nailed on each Side of it: And to prevent the wearing away of its lower Edge, by much Motion to and fro, there were Iron Laps, three Inches broad, one in the Middle, and one towards each End, nailed round its Bottom; which Laps rested on Iron Plates, let into the Bottom Boards: And also the like Iron Laps at each End, near the lower Corners, which worked against the like Iron Plates, to prevent the Midriffs bearing at either End, against the End-boards, which would make them move very heavily.

148. THE outward Boards of the Ventilators were all, excepting the Cover, made of inch-thick Deal, and their Edges well joined with Grooves and Tongues in them; the Cover or upper Boards, were only half-inch thick, that they might the better bend into a circular Form, in which Form they were fixed by Circular Battings on their Outside: All the Joinings of the Boards had strong brown Paper pasted on them, and those of the Midriff on both Sides. The Coverings were made of Fir-boards half-inch thick, with
circular

circular Battings Q Q, both to make them retain their circular Form, and to strengthen them.

149. THE Valves at which the Air entered, were made on the fore-sides of the Ventilators at Z, and just opposite on their back-side, where they could be made very large; for the larger and lighter the Valves be, so much the easier the Ventilators work; if they are between a fortieth and a fiftieth Part of the Breadth of the Midriff, they will do well. As to the Valves thro' which the Air passed out of the Ventilators, there was a Necessity for having them, at the End U U; where, by being too small, it caused the Ventilators to work so much the harder; whence the Air was conveyed by a large Box B, M, N, up to the large short Trunk X, thro' which it rushed into the Kiln: One half of the Stream of Air, beating against the Side of the hot Cockle, was thereby spread sideways, backwards, as well as upwards; the other half of the Stream of Air went directly forward, close by the Front of the Kiln, and then turned round the other side of the Cockle, as well as upwards, whereby this cold Air was soon warmed: By which means it was spread, so as to pass pretty uniformly up thro' all Parts of the Hops.

150. THERE

VENTILATORS. 95

150. THERE was also another Passage made, for the Air of that half of the Ventilators which was next to the Kiln, to be conveyed by a Trunk, into the Kiln behind. When this Method is used, then its other Valve U must be stopped, by a Stick thrust against it, thro' a small Hole, in the Side of a Box, which is opposite to it. By this means, the Air may be conveyed, partly one way, and partly the other, as shall be found best.

151. I FIXED also in the same manner, just opposite to these, a like Pair of Ventilators, to the Side of the adjoining Kiln, which was eight Feet distant from the other; so that by the Motion of the Lever G T F, which was in the Middle between them, Air was conveyed at the same time into both Kilns, by the Work of two Men, who were at times to be relieved.

152. THE great Quantity of Air conveyed thereby, may be thus estimated; one of these Ventilators, containing nearly Forty-eight Cubic Feet: the half of which Quantity being driven out at each Stroke, *viz.* twenty-four Cubic Feet; this at sixty Strokes in a Minute, will be thirty-six Tuns in a Minute, which amounts to Two Thousand one Hundred and Sixty Tuns in an Hour, if all the Air contained

tained in the Ventilators passed off thro' the Valves : but as some escapes by the Edges of the Midriffs, an Allowance must be made for that ; which supposing it to be one Tenth of the Whole, then One Thousand nine Hundred and forty-four Tuns of Air in an Hour are conveyed, which rushed into the Kiln very briskly ; insomuch, that if a very thin light Handkerchief was spread on the Hops, it was very sensibly moved. The same thing might also sometimes be observed, when there was no Ventilation, *viz.* when the Wind set so as to blow briskly into the Kiln.

153. BUT notwithstanding this great Quantity of Air was thus conveyed in by the Ventilators, yet it was very observable, that there was a considerable Indraft of Air, at the Entrance of the Kiln, which was seven Feet high and two Feet wide : for if a Handkerchief was held there, it was drawn inwards by the Indraft of the Air ; yet it was very sensibly less, when the Ventilators conveyed Air in, than when they did not.

(XIX.)

154. **T**H E R E are usually dried on these and the like Kilns of sixteen Feet square, sixty Bushels of Hops in twelve Hours.

Septem-

VENTILATORS. 97

September the 7th, eighty Bushels of wet Hops were dried by Mr. *Baker* of *Sandwich*, a very skilful Maltster and Hop-drier, in six Hours and forty Minutes, fine coloured, soft, and well dried.

155. SEPTEMBER the 8th, an Hundred Bushels were dried by him, in seven and a half Hours, fair and good conditioned.

156. SEPTEMBER the 9th, in order to try what Effect the united Air of both Pair of Ventilators would have ; by a Trunk of Communication at X X, the Air of both Pair was conveyed into one Kiln ; it being stopped from passing into the other Kiln : And there were sliding Shutters made, to stop or open this Trunk of Communication when required. An Hundred Bushels of Hops were thus dried, by the common Drier, in six Hours, but they were not well coloured.

157. SEPTEMBER the 10th, 120 Bushels of damp cold Hops (it being a very cold damp Morning when they were picked) were dried by Mr. *Baker*, in eight Hours, with the double Ventilators, fair, fine, and thorough dried.

158. HENCE, we see the good Effect of conveying great Quantities of Air, up thro' Hops, while they are drying, and that especially when in calm moist Weather being wet

H (which

(which is often the case of Hops) they are in danger of being discoloured and spoiled, by scalding and stewing long in their damp Wreak: Now Air being the wings, on which damp Vapours ascend, the greater the Plenty of Air, so much the sooner, as it is well known, will any thing be dried; especially when that Air is not only dry, but hot too.

159. DID the Wind constantly blow briskly, through the whole or greatest Part of Hop Seasons, there might be a sufficient Quantity of cold Air conveyed into the Hop-Kilns, without Ventilators; for it was observed (No. 153.) above, that when a brisk Eddy of Wind blew in at the Kiln-door, it moved a Handkerchief lain on the Hops, as much as the Air from the Ventilators did. And therefore it will be of good Service to Hop and Malt-driers, whether they have Ventilators or no, not only to make a large Stoke-hole or Fire-place, for Plenty of Air to enter into the Kiln; but also to make large Inlets, on every side, if possible, of the Room in which the Kiln stands; that which way soever the Wind blows, it may have a free Entrance; and being, by closing the Openings on the other Sides of the Room, hindered from passing out again, it will be driven in Plenty into the Kiln,
or

VENTILATORS. 99

or 'up thro' the Hops : and as there are frequently Winds in the Hop-season, this Method will be very serviceable in drying them. But in wet and calm Seasons, these Inlets for the Air will be of little Service ; at which times the Ventilators will be most of all necessary. The having proper Cowls on the Tops of the Kilns, to promote the conveying off of the hot Air and Steam, will greatly promote the freer Entrance of Air below.

160. BUT there is an Error, which some Hop and Malt-driers are apt to fall into, *viz.* they seeing that the more a Fire is narrowed in, at the Fire-place, so much the brisker it burns ; are apt thence to conclude, that there is thereby, not only a stronger Fire, but also a greater Indraft of Air, because they observe the Air to rush in faster, through and over the Fire, when the Fire-place is narrow, than when wide : which is just such a mistaken way of Reasoning, as if a Man who sees Soldiers, for greater Dispatch, running through a Lane or narrow Defile, should therefore conclude, that a whole Army could march sooner thus, through a narrow Pass, than over an open Plain, walking only a Foot-pace. It is accordingly observed, that such narrow Fire-places are apter to give a scorching Heat, than

wider ones ; the Reason of which is, that the narrow ones give Heat with little Air, the wider ones Heat with a greater Plenty of Air, to carry off the damp Vapours.

161. Now notwithstanding this great Quantity of cold Air was conveyed into the hot Kiln, both from the Ventilators, and from the Indraft, at the Kiln-door, yet it passed hot up through the Hops, in proportion to the different Degrees of Heat that there was in the Kiln ; for so rare and light a Body as Air, both heats and cools very soon.

162. HENCE we see, how easy it is to procure a great Quantity of hot Air, in order to dry any kinds of Goods with it, by means of Ventilators : for if notwithstanding the great Quantities of cold Air which entered the hot Kiln, it yet passed up hot through the Hops ; then doubtless in like manner great Quantities of hot Air may be drawn by Ventilators from a hot Stove, to be conveyed thereby to any Goods that are to be dried.

163. I TOOK the Degree of Heat, among the drying Hops, by a mercurial Thermometer, which was graduated according to *Fahrenheit's*, in which the freezing Point is thirty-two Degrees, Blood-heat ninety-six, and the Heat of boiling Water 212. This Thermometer

VENTILATORS. 101

meter was graduated to 300 such Degrees. I found the Heat of Noon-tide Sun-shine at the End of *August*, under a Wall 102 Degrees. But as the freezing Point is a fixed determinate Point, I shall begin the Graduation thence, deducing the thirty-two Degrees below Freezing, with which this Thermometer begins: And then Blood-heat will be sixty-four Degrees above Freezing, Noon-tide Sun-shine 70, and that of boiling Water 180.

164. SEPTEMBER the 9th, after two Hours drying with Ventilation, the Heat at the Bottom of the Hops, next the Hair-cloth between the Bars or Laths, was 120 Degrees, *viz.* two thirds of the Heat of boiling Water. In the middle of the Hops the Degree of Heat was 76, on the Top of the Hops 60 Degrees, seven Feet above the Hops 63 Degrees, it being usually two or three Degrees hotter there, than on the Surface of the Hops. And this sixty-three Degrees of Heat, *viz.* nearly Blood-heat, was very irksome and incommodious, to continue in for a time: Much more so than the abovementioned 70 Degrees of Heat, in dry hot Sun-shine: The great Irksomeness of this lesser damp Heat, being occasioned, not only by incommoding the Respiration, with a foul Air, but also by relaxing the Surface of the

H 3 *Small text* Body,

Body, by this damp Air. And the like Difference is commonly observed, between a damp and a dry cold Air; the former with a less Degree of Cold incommoding us much more than the latter, with a much greater Degree of Cold. Now the raising the Heat to 120 Degrees in so short a time as two Hours, proved too great a Heat, especially with wet Hops, for they were not well coloured, Numb. 190.

165. SEPTEMBER the 10th, when 120 Bushels were well dried with Ventilation; after two Hours and a half, the Heat at the Hair-cloth was 118, in the middle of the Hops 66, on their Surface 62; half an Hour after, *viz.* at the End of three Hours drying, the Heat at the Bottom of the Hops was abated six Degrees, *viz.* to 112; at five Hours End it was risen to 117, and was 80 on the Hops. At the End of the drying, which was in eight Hours, the Heat at the Hair-cloth was abated to 88, and yet the Cockle was very red-hot, much more than any time before, during the drying of this Kiln of Hops. Since then dense Vapours among the Hops acquire a greater Degree of Heat than this, with a cooler Cockle; therefore the greatest Care and Skill is needful while they are damp. And here seems to be one of the principal Uses and Benefits

VENTILATORS. 103

nefits of these Ventilators, *viz.* to carry off the Moisture the faster, and thereby to lessen both the Quantity of it, and the Time of the Hops stewing in it. Another considerable Benefit of them is, that they dry Hops in much less time, and consequently not only less Fuel, but also fewer Kilns will be needful, where several are used.

166. By comparing at several times the different Degrees of Heat, given to ventilated and unventilated Hops, I found that the ventilated Hops at equal Times, from their being first laid on the Kilns, could bear considerably greater Degrees of Heat, than the unventilated ones.

167. By the Help of such a Thermometer, many useful Observations might be made, in relation to the different Degrees of Heat, which wet Hops, or those which are not wet, require in different Stages of their drying.

(XX.)

168. **W**HEN Hops, especially wet ones, lie many Hours in a Heap, before they are laid on the Kilns to dry; they are apt to get Damage, and be discoloured. To prevent which Inconvenience, I fixed in the same Hop-house two Pair of such Ventilators,

H 4

lators, as are described in *Fig. 2.* to the Joist, which bear up the Floor on which the green Hops are laid; they were seven Feet eight Inches long, and four Feet four Inches broad, and twelve and a half Inches deep within side; so there was room for the Midribs to move up and down a Foot: But at the other Valve End, they were twenty Inches deep, for the sake of the larger Valves, which were each fourteen Inches long, and eight deep: One Inch of the Substance of the Valve-board being left at the Top, two in the middle, and one at the Bottom, for the Valves to be nailed to and fall against.

169. FROM these Valves the Air was conveyed in and out of the Ventilators at the rate of about 2712 Tuns in an Hour, up into a large Air-trunk, which was fifteen Feet long, whence it run between wooden Bars nailed on the Floor, which were four Inches deep, two Inches thick, and two Inches distant from each other: But it had taken up much less Stuff, if Laths or Bars only two Inches thick had been nailed on the Floor, at the Distance of fifteen Inches; and across them, other Laths, at two Inches distance, as described in *Fig. 8.* On these was laid a Hair-cloth seventeen Feet long, and fifteen broad.

170. WHEN

VENTILATORS. 105

170. WHEN the Ventilators were worked, which was done by means of another Lever fixed sideways, like a Pump-handle to one End G or F of the long Lever, *Fig. 2.* then a Handkerchief, which was spread on the Hair-cloth, was blown up several Inches; but not so, at those Parts which were far from the great Air-trunk ZXY, *Fig. 8. viz.* because the Air passing most freely through the Hair-cloth, was all wasted, long before it reached to the farther End; for which Reason, the Air passing also very freely through Hops, they ought to be laid four or five Times thicker, near the great Air-trunk, than at the farther End; where the Interstices of the Bars were closed up with a Board, and pasted with Paper, as were also all the Joints of the Boards of the Floor, to prevent the escaping of Air.

171. THESE Ventilators will be of use not only for preserving of Hops, but also for drying cold, and sweetening musty Corn. With a View to which, a sliding Shutter was fixed in the great Air-trunk ZZ, to stop its ascending up through the whole Hair-cloth, in case one Part of it shall be sufficient for the Quantity of Corn that is to be ventilated; for the less the Spread of the Hair-cloth, so much the faster will the Air pass up thro' it.

(XXI.)

172. **A**S to Malt, being desirous to try, what Degree of Driness might be given it, by being ventilated upwards with common cold Air; *March* 22d, there being a dry North-east Wind, I procured a Pack of undried Malt, and put it into a Box, with a Canvas false Bottom, where it lay about four Inches thick. It weighed eight Pounds, seven Ounces and a half, and one Drachm. During the first six Hours Ventilation upwards, it wasted at the rate of three Ounces and a half every two Hours; during the following fifty Hours Ventilation, it wasted nearly at the rate of one Ounce and a half every two Hours; and for the remaining last twelve Hours, it wasted nearly at the rate of half an Ounce every two Hours. So that in sixty-eight Hours, it wasted in all four Pounds, twelve Ounces and a half, *viz.* near one third of the whole Weight: in which time there passed through the Interstices of the Malt 244,000 Gallons of Air. This Malt when thus dried was crisp and hard to bite, but not near so hard as Kiln-dried pale Malt, which is 24 Hours in drying: on which account it did not grind so well, and some of it, tho' close corked up in a Bottle, did

VENTILATORS. 107

did after some Days grow less hard, *viz.* probably because the Moisture near the middle diffused itself towards the drier and harder outside. Ale was brewed with this Malt, which was very well tasted, but not so pale as was expected; which might be owing to the manner of preparing it in the Couch.

173. BUT if instead of cold, plenty of hot Air be conveyed upwards through Malt, it will then dry, not only much faster, but also better than in the common Way of drying. For when, for Trial, pale Malt was dried on one of the abovementioned Kilns, Numb. 145. and ventilated, the first Kiln was dried in eleven Hours, and a second Kiln in nine Hours; during eight Hours of which nine, the drying Malt was ventilated: whereas a like Kiln of unventilated Malt was at the same time twenty Hours in drying, the Wind blowing very fresh; whereby, the more Air being conveyed in at the Kiln-door, brought it on sooner than it would otherwise have done; a Kiln of pale Malt being usually about twenty-four Hours in drying and hardening.

174. THE abovementioned Mr. *Baker* observed, that though the Weather was wet, and the Tiles very damp within, yet the Moisture went off the Malt, without Sweat, with Ventilation,

tilation, in much less Time, than in the other Kiln without Ventilation, which sweat very much; and consequently the Malt which was dried without Sweat, was much the better of the two. This Malt, he says, was very good, being dried pale, and made a pale Wort of a fine Taste. Though he observes, that it will not be so pale with a Cockle-kiln, as when dried in an open Kiln, with Coake, or *Welch* Coal.

175. ONE Pair of these Ventilators being given him, he conveyed them to *Sandwich*, and fixed them to his open Malt-kiln there, which had no Cockle in it: where he found that by Ventilation, he could dry either pale or brown Malt, in half the usual Time, with a somewhat larger Fire; for as in drying Hops, so in drying Malt, a greater Heat may be given when ventilated, than when not. And the pale Malt thus dried, was paler and lower coloured, and the brown much brighter, than that which is dried without Ventilation: Whence he concludes, that both Sorts being thus dried without Sweat, will make better Beer, than if dried in the usual Way.

176. If the Labour of working the Ventilators, during the whole Time of drying, shall be thought too much; he is of Opinion, that

VENTILATORS. 109

it would do good Service, if they were worked only so long, as the principal Damp continued among the Malt; especially in a still, moist, heavy Air.

177. HE observed, that Malt lying closer together than Hops, a light Handkerchief laid on it, was not so sensibly moved by Ventilation, as when it lay spread on Hops.

178. THE usual Heat given to pale Malt, which is to be dried in twenty-four Hours, is about fifty-two Degrees above freezing, which is twelve Degrees, *viz.* near one Sixth below Blood-warm: But when towards the latter End of drying, the principal Moisture is gone off, then the Heat of the Malt is increased to 138 Degrees above Freezing, *viz.* more than double the Heat of Blood, which is 64 Degrees. And this Degree of Heat both hardens the Malt, so as to make it keep long well in Store, and also gives it an agreeable Sweetness.

179. IN order to make brown Malt, a much greater Degree of Heat is given it, while it is in a damp Sweat.

(XXII.)

180. **T**HESE Ventilators may also be of use to those who take the Hulls off from any Grains, by moistening them first:
Thus

Thus whited Pepper may be well dried ; and Starch-makers may thus dry their Starch, with warm Air from a Stove. Several kinds of Sweatmeats may be dried thus, and also be preserved very dry and free from Damp or Mouldiness, by ventilating them now and then for a little time.

181. AND if the frowzy Air of *Larders*, *Pantreys*, and *Safes*, be now and then thus exchanged for fresh Air, it will contribute to the keeping of the Meat sweet, and free from Mustiness, much the longer. See more Part II. Numb. 274.

182. AND since a moist Air conduces much to the rusting of Iron, they would probably be very serviceable, in keeping Arms bright in large Armories, such as are in the *Tower of London*.

183. THE Expence of Trial with these Ventilators in these Cases, is inconsiderable, and the Benefit proposed great. They will doubtless also be of service in many other Instances, which do not occur to me, but may hereafter be thought of, and applied by others to be serviceable to them in their several Professions.

184. IT will be a great Satisfaction to me, if these Things shall prove beneficial to Mankind ;

VENTILATORS. III

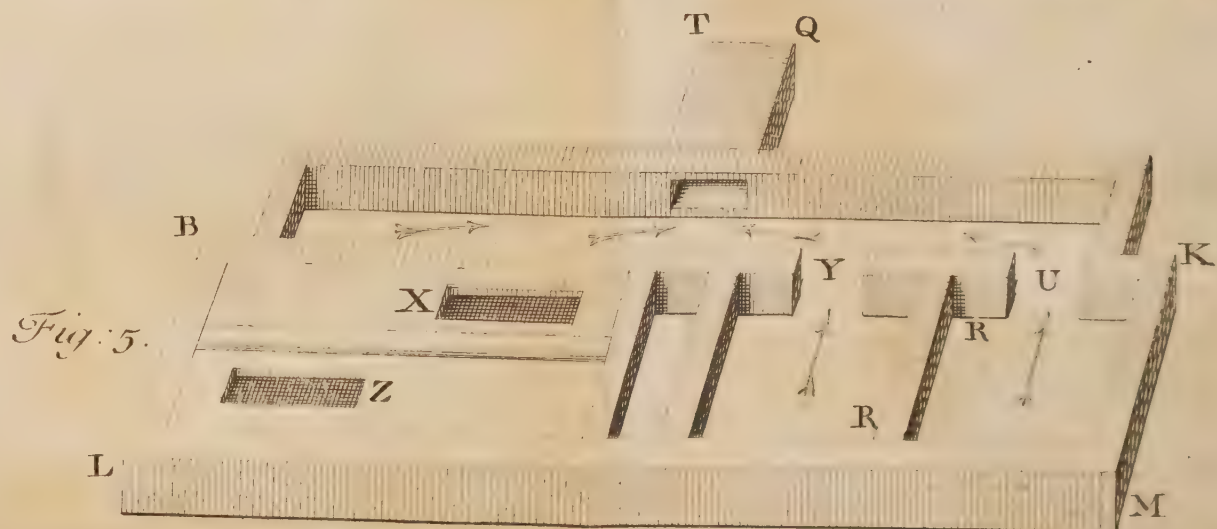
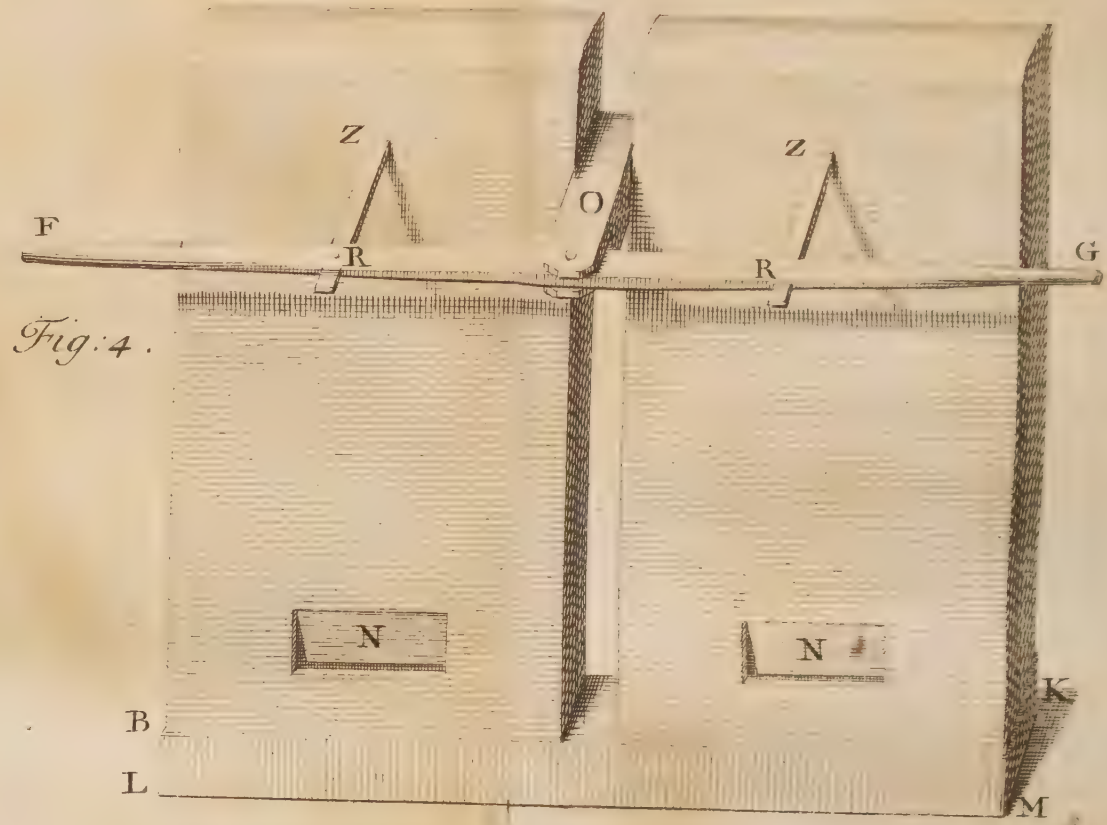
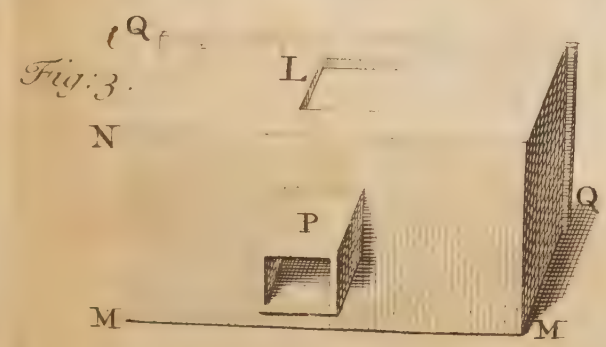
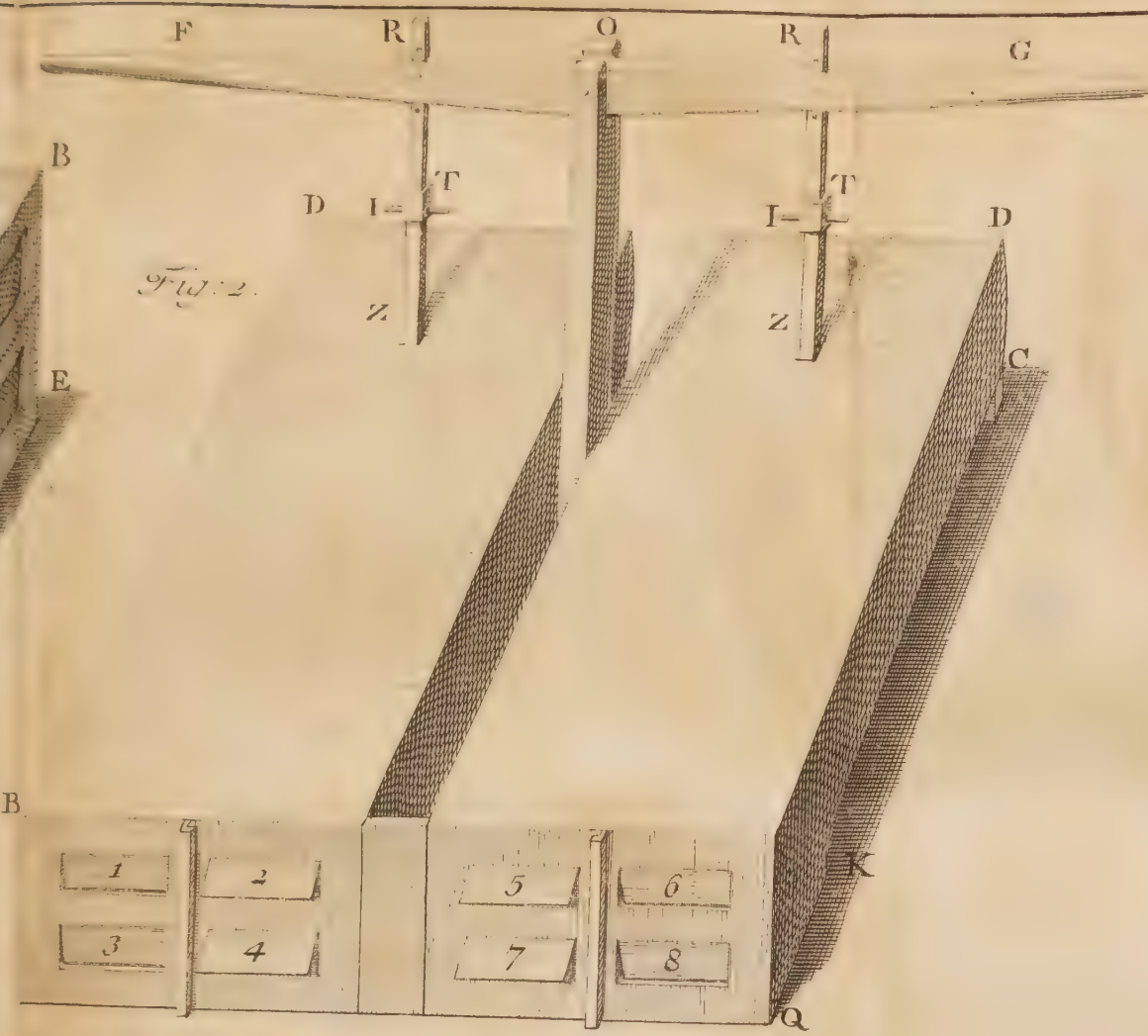
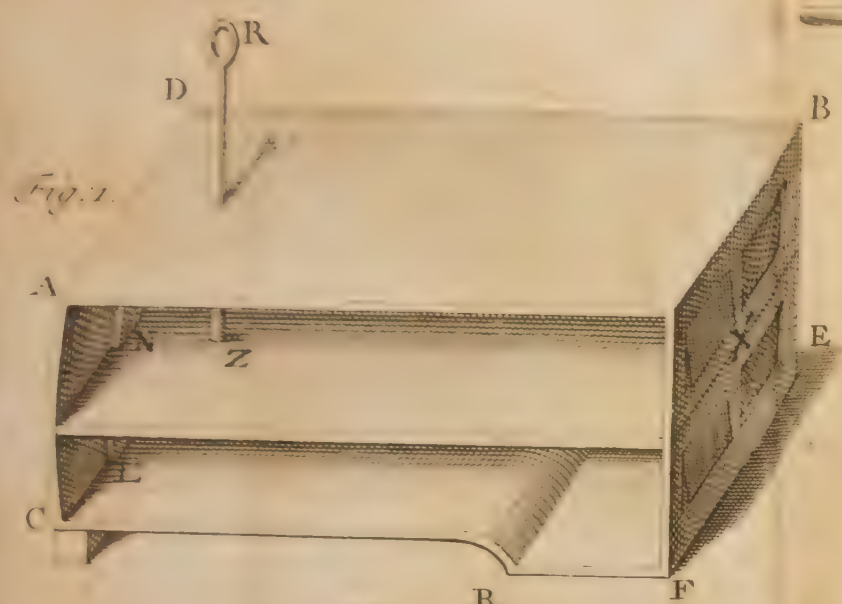
kind ; especially to those numerous, useful and valuable Persons, *who occupy their Business in great Waters* : Whom I have laboured in many Ways to do the best Service I could. And oh ! that I could prevail with them, to be in earnest so true to their own Interest, as not to destroy their Health and shorten their Lives, by the intemperate Use of distilled Spirituous Liquors, such as Brandy, Rum, Arrack, &c. The Health of many of them is impaired, and dangerous Sickneses are often occasioned, by the very noxious rancid close Air in Ships : But the Number of those, who lose their Lives by this, and all other Dangers and Difficulties they are exposed to, is small in Comparison of the vast Multitudes that are destroyed by these pernicious Liquors, especially in hot Climates. And will not the yearly Destruction of Thousands, nay of Millions all over the World, deter them from it ? Will not the strong natural Desire they have to *live long and see good and healthy Days*, prevail with them to avoid this Bane of Mankind ? Will they, in spite of all these Arguments, be their own Executioners, and consign themselves over, not only to present, but eternal Death also ?

End of PART FIRST.

A
GENERAL INDEX
 Of the Matters contained in this First PART.

A	
A <i>IR</i> dry, why it exhilerates	71
is very electrical	88
C	
<i>Churches</i> , their Air to refresh	41
<i>Corn</i> , to preserve by Ventilation	57. 76
smutty, to clear	64
in Ricks or Mows the better to preserve	79
D	
<i>Drams</i> , most pernicious	76. 112
G	
<i>Gunpowder</i> , to dry by Ventilation	82
to preserve dry	87
H	
<i>Hops</i> and <i>Malt</i> , to dry by Ventilation	91. 97. 106
and without Ventilators	98
I	
<i>Infants</i> ought not to be swathed	55
nor their soft Skull closed	56
<i>Infection</i> , to purify	43 to 46
M	
<i>Malt</i> , to dry by Ventilation	97
and without Ventilators	98
Q	
<i>Quarentine</i> , Ships and Goods to purify	46
R	
A Respirator described	51
S	
<i>Ships</i> , to ventilate	20 to 28
infected to purify	43
V	
<i>Ventilators</i> , large their Description	1 to 9
the great Quantity of Air conveyed by them	10
easily to be worked	28
small described	47
their Uses	49. 89
<i>Ventilation</i> , its Reasonableness and Importance	32 to 42





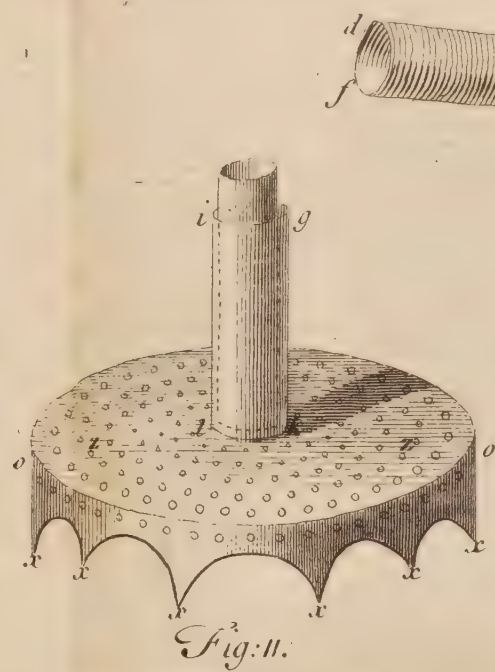
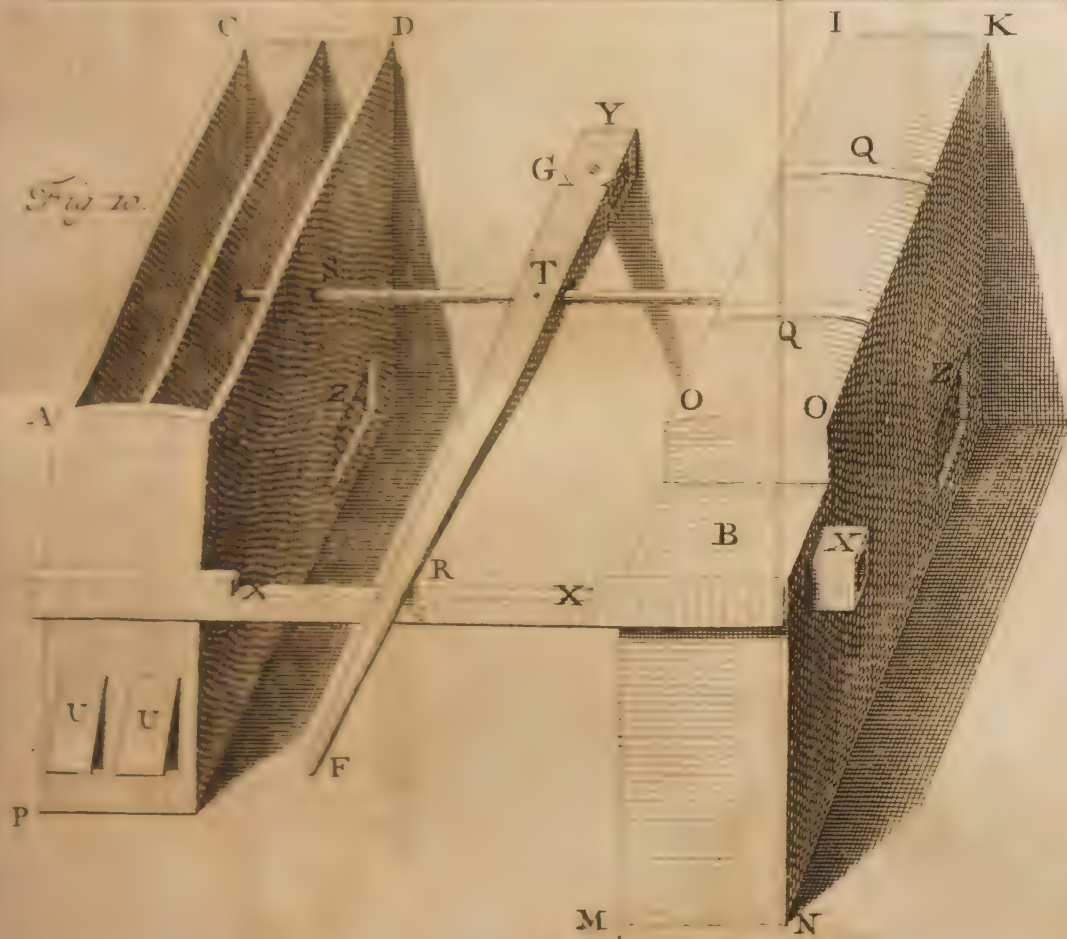
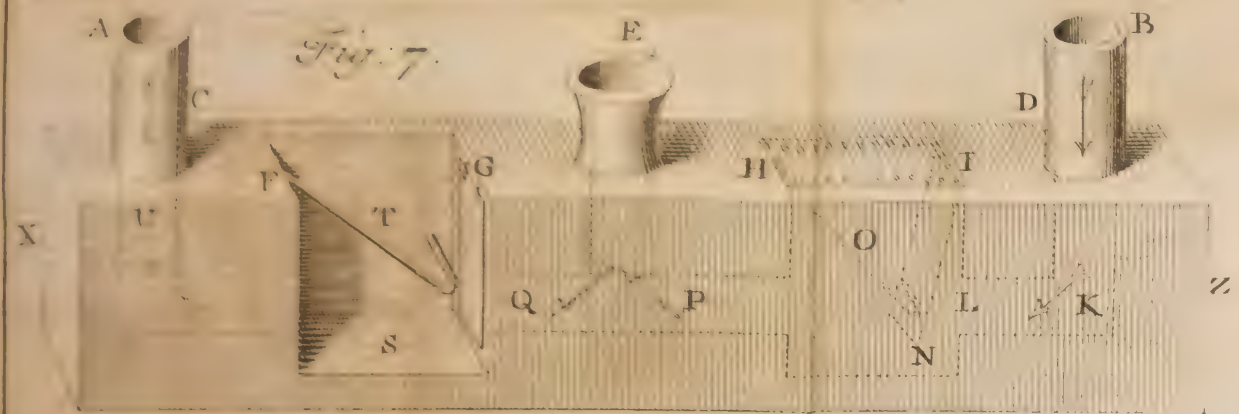
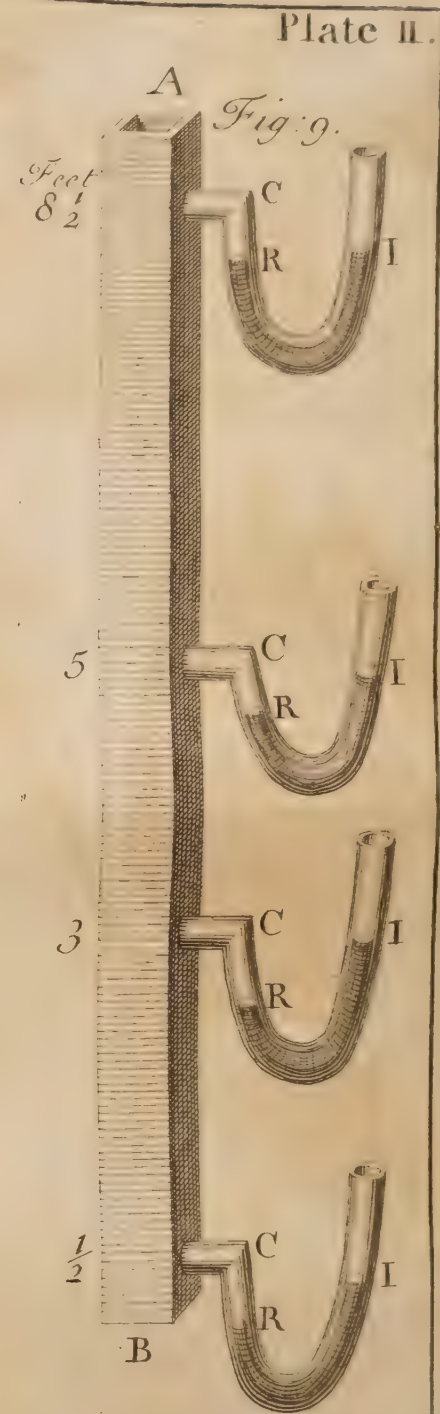
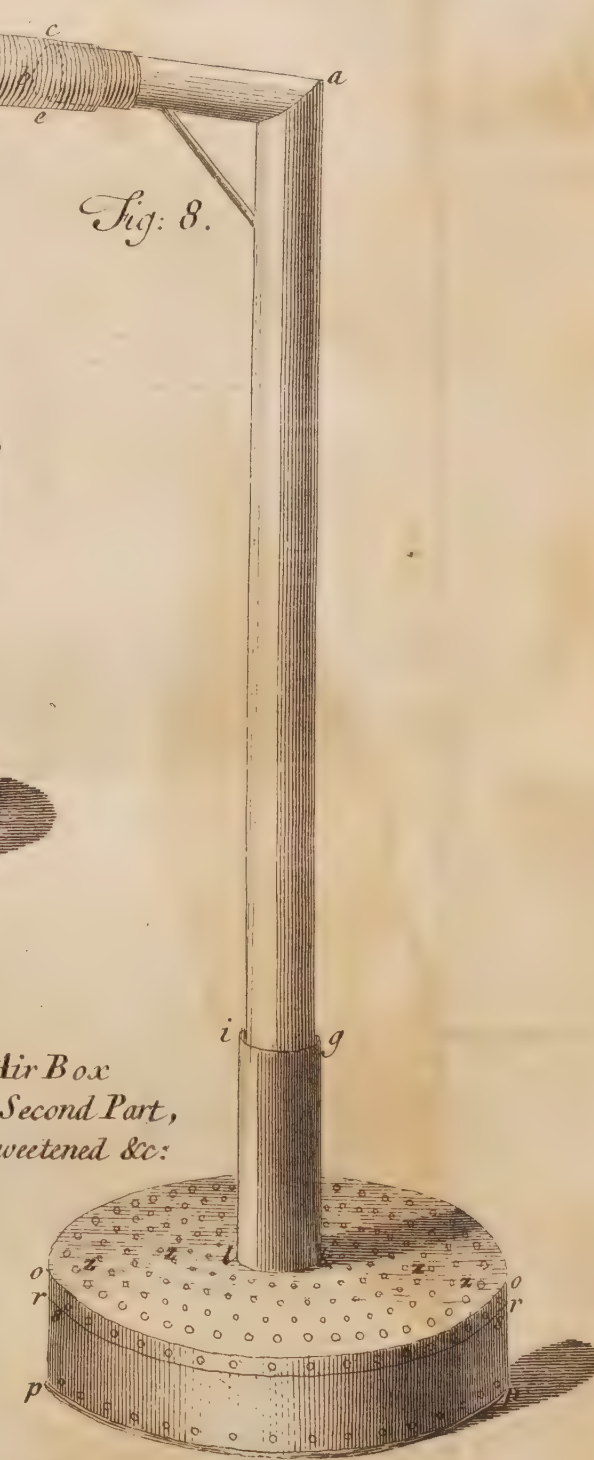


Fig: 8 & 11. is the tin Air Box
mentioned near the End of the Second Part,
by which Stinking water is Sweetened &c:





A
T R E A T I S E
O N
V E N T I L A T O R S.

W H E R E I N

An Account is given of the HAPPY EFFECTS of the several TRIALS that have been made of them, in different *Ways* and for different *Purposes* : Which has occasioned their being received with general *Approbation* and *Applause*, on account of their UTILITY for the great Benefit of Mankind.

A S A L S O

Of what farther HINTS and IMPROVEMENTS in several other useful *Ways*, have occurred since the Publication of the former *Treatise*.

P A R T S E C O N D.

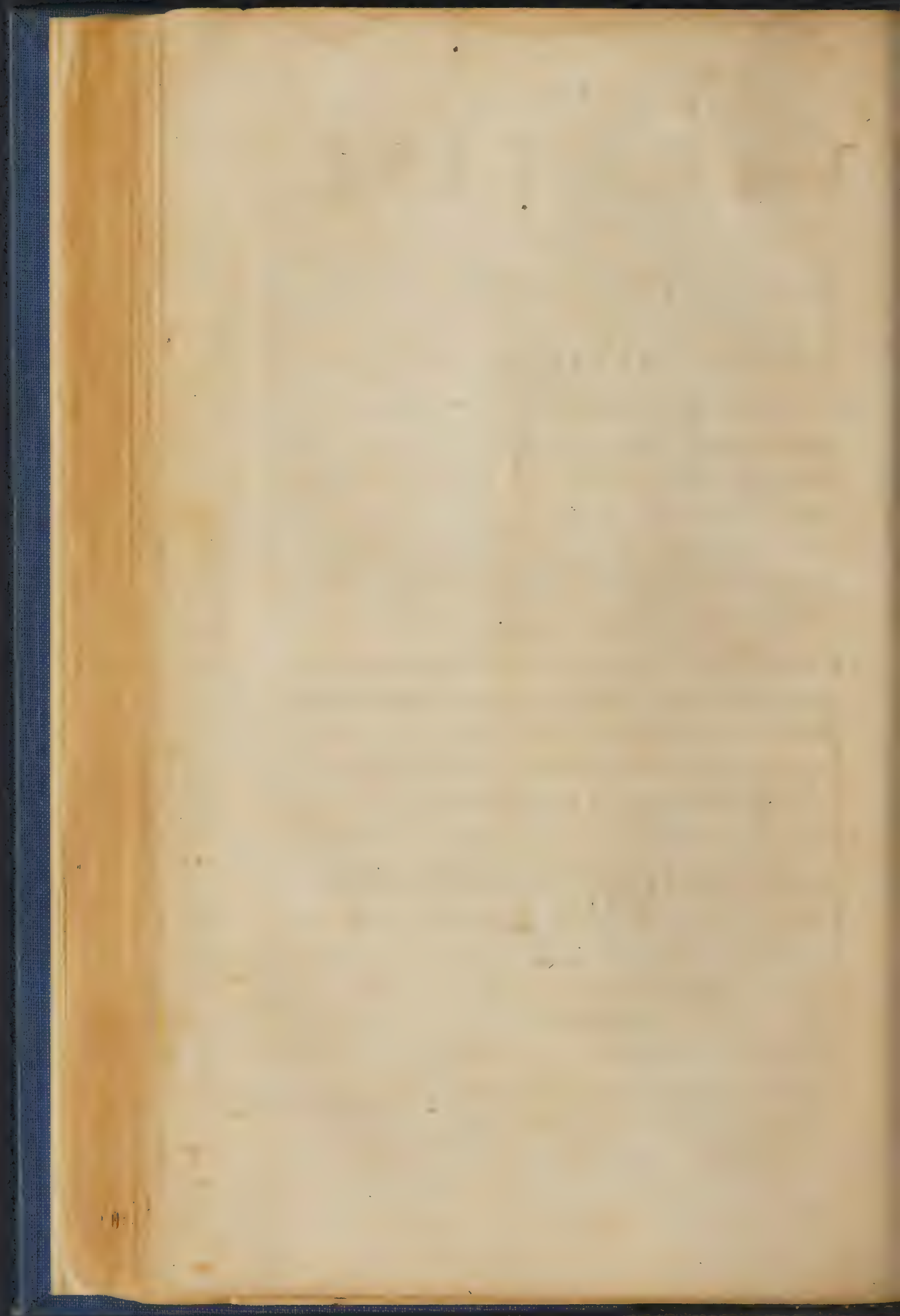
By *STEPHEN HALES*, D.D.

Clerk of the Closet to her Royal Highness the Princess of *Wales*, F.R.S. and Member of the Royal Academy of Sciences at *Paris* and *Bologna*.

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A
S E C O N D P A R T
T O T H E
T R E A T I S E
O N
V E N T I L A T O R S , & c .

237. (*) **A**S Ventilators are found to be greatly and extensively beneficial to Mankind, so as thereby to have a considerable Influence on the Affairs of the World, it will hereafter be Matter of Wonder, that so plainly self-evident a Benefit should be so many Years proposed before the World could be prevailed on

* The Paragraphs are here numbered, in a continued Series, from the last of those in the first Volume, that References may thereby be the better made to and fro' to either Volume. The Subject-Matter in this being placed in the same Order, as in the first Volume. The Plates and Numbers of the Figures are continued on also in the same Manner.

on to receive them ; which proceeds from a general Backwardness to every new Proposal, not caring to give themselves the Trouble thoroughly to consider and examine them. But it is reasonable to believe, that Ventilators will, from Time to Time, come into more general Use, not only for the several important Purposes here mentioned, but also for many other, at present unthought-of Uses, to the great Benefit of Mankind.

238. New Discoveries are apt to be despised, especially by those who are incompetent Judges of them ; and that, no Wonder ; for we are Slaves to old Habits and Customs, even to the Degree of suffering Inconveniencies, which we might easily remedy. And this very Disposition, is sometimes beneficial to us, as it enables us the better to bear Inconveniencies, which we cannot remedy. But in all other Cases where a Remedy can be had, it is renouncing our Reason, blindly to follow the old Track we are in, only because it is a beaten one, or because we will not give ourselves the Trouble, to enquire whether we cannot find a shorter and more commodious Way.

3

240. AND the more important the Research is, so much the more diligent should we be in our Enquiries after it. And such is the Subject of our present Enquiry, viz. How to preserve the Health and Lives of Men in Ships; as also the Ships from decay-

B 2

ing,

ing, when laid up in Ordinary. And as the Malady in both Cases, principally arises from damp, foul, stagnant, close confined, putrid Air, so the obvious and only Remedy is, to exchange the Air of Ships so often, as not to give it Time to putrify. And, when probable and proper Means for doing it are proposed, one would be apt to think, that all should readily approve of so self-evidently reasonable a Proposal, and not supinely reject it. But, notwithstanding, it has been received for many Years, with great Coldness by some, and Contempt by others; yet it has at length prevailed, so as to be brought by repeated Trials, to more and greater Perfection; to the great Benefit of Mankind, not only in relation to Ships, but also in many other Respects.

241. THOSE who are ignorant of, or do not consider the Reason of Things, and are used only to the practical Part, and habitually execute what they have been taught; such are mere Copyists, who servilely follow the Track which has been traced out for them; Wholly taken up in Copying, they consider not the Reasons why Things are done so, or so; they have no Desire to do better.

VENTILATORS. 5

better. They seem to be of opinion, that the Masters, of whom they learned, had brought Things to the utmost Perfection; not considering how little we know, in comparison of what we are ignorant of, and that consequently there will ever be Room for more and farther Improvements, and useful Discoveries. If any new Thing is proposed to them, they reject it without examining, or else without duly weighing, the Advantages, or Inconveniencies they labour under; they only endeavour to raise Difficulties and make Objections, and to find Reasons for going on in their old Way.

242. THE ingenious Author of the Letters, called *Sir Thomas Fitzosborne's*, Vol. II. Letter 506. observes, ‘ That there is not a more
 ‘ singular Character, than that of a thinking
 ‘ Man.— That Thinking is one of the last
 ‘ exerted Privileges, even of cultivated Humanity.— That Pride and Indolence greatly contribute, to keep this Faculty of the
 ‘ Soul unemployed.— For this Reason, the
 ‘ greater Part of our Species, generally choose,
 ‘ either to seize upon their Conclusions at
 ‘ once, or to take them by Rebound from
 ‘ others, as best suiting with their Vanity or
 ‘ Laziness.

‘ Lazinefs.— This will account for the flow
 ‘ Steps, by which Truth has advanced in the
 ‘ World on one Side, and for those absurd
 ‘ Systems, which at different Periods, have
 ‘ had an univerfal Currency on the other.’
 It is the juft Obfervation of the Poet, *viz.*

‘ Custom, that Reason’s Foe fo oft appears,
 ‘ Inchants whole Millions to her wide Com-
 ‘ mands,
 ‘ Lo ! gaping Multitudes the Nod attend,
 ‘ Revere her Dictates, and her Laws defend.’

Henry Jones’s Poems, p. 153.

243. NOT that I am pleading for a blind,
 precipitate Receiving of all new Propofals;
 this would be to run into another dangerous
 Extreme, For there are many more, im-
 proper, injudicious, trifling, new Propofals
 projected, than there are judicious useful
 ones. So that it is right, not to receive new
 Propofals, even tho’ they feem very useful
 and important, till their Reasonablenefs and
 Practicablenefs are thoroughly examined by
 competent Judges. For when we follow
 long-beaten Tracks, as we know both the
 good and bad of them, we can act according-
 ly;

VENTILATORS. 7

ly; but, in new Things, which do not promise very great Advantages, there may be unforeseen Defects. On the other hand, tho' the most promising Discoveries may have some Inconveniencies, yet they are not to be rejected by considerate Persons, who will endeavour to rectify what is amiss, and also to make farther Improvements thereon. Many of the Difficulties are often foreseen, by superficial Thinkers; but, to remove the Difficulties, and to make the best Use of the Benefits of Discoveries, requires more Candor, Thought, and judicious Consideration. It is very right to make just Objections to new Proposals, that the Merit or Demerit of them, may be the more thoroughly examined. But the Objections of the Prejudiced, and of incompetent Judges, when they are of no Weight, ought not to discourage us in the Pursuit of useful and new Discoveries. For, as it is obvious to observe, that a considerable Part of Mankind do not think for themselves, but run in with the Stream of current Opinions, it being in many Cases for obvious Reasons best for them so to do; so neither ought the Disapprobation, or Approbation of such, to be of any Weight.

244. THE Tops and Bottoms of Ventilators may be nailed with thin Laths of Board under the Heads of the Nails, by this means the Nails may easily be drawn out without damaging the Boards, when the Laths are split away; and, in order to prevent the Inconvenience of the swelling and shrinking of the Midribs (*Num. 4.*) by Moisture or Driness, the following Method is found effectual, *viz.* to have Tenons of the short Rails, to reach thro' the Mortices of the long Side-Rails, and to be pinned near the outer Edge of the long Rails, and to have a dove-tail Fastening by means of Wedges, dipped in Glue, drove in at the Ends of the Tenons, whereby on the swelling or shrinking of the long Rails sideways, these Rails may have Room to swell and shrink inwards, on the Tenons of the short cross Rails, on about a Quarter of an Inch of Space left for that Purpose, between the Shoulder of the Tenon and the long Rail. The Pannels are to enter into deep Grooves, thereby to allow Room for their swelling and shrinking. And as the Boards which cover the Tops and Bottoms of the Ventilators lay across them, therefore the Sides of the Ventilators will not be either drawn in or pushed out, by the Driness or Moisture

VENTILATORS. 9

Moisture of the top or bottom Boards, because Fir lengthens and shortens very little by Moisture or Driness, as I have found by many Trials. It may be well also to keep the Side-Boards at a due Distance, by a cross Bar or Strut, fixed within from Side to Side, near the Middle, yet so as not to hinder the rising and falling of the Midribs. By which Precaution the Edges of the Midribs may approach the nearer to the Sides of the Ventilator; and thereby they will not only convey much more Air, but also a great deal of fruitless Labour will be saved, by preventing a large Escaping of Air at the Edges of the Midribs. The Ventilators may also be somewhat the less, which in some Cases may be of Importance. The Lengthening and Shortening of the Midribs lengthwise will be very inconsiderable, because the long Rails reach the whole Length. The Ventilators need not be separated, as in *Fig. 1. Plate 1.* but joined close together.

245. BROWN Paper made of tarred Ropes, is proper for pasting over the Seams of Ventilators, because it will not tear when the Boards shrink, and probably Rats will not eat it. Mr. Yeoman finds it best to nail Battings
across

across the Bottom and Top of Ventilators, so as to have them like a Door, to open, and lift off all together, to be fastened down with several Wood Screws or Hasps. He covers the whole Surface of the Valves with tanned Sheeps Leather, which serves also for Hinges; and finds, that, in order to abate the Noise of the Valves in Hospitals, it is proper to have them narrow, but long.

246. HINGE Ends of the Midribs may be very close to the Valve-board or Frame, if the Iron Axils be flat on one Side, and rounding on the other; whereby they will keep close to the Valve-board, though moved a little circularly by the rising and falling of the Midriff. The Axils *z, c, x*. *Fig. 12. Plate 3.* are to be fixed with their flat Side to the Ends of the Midribs, not only with Wood Screws, but also with broad Tenons of Iron, wilded and incorporated into the Axils; which Tenons enter into Slits or Mortices, cut at the Ends of the long Rails, the Ends of which Rails are strengthened by long Iron Plates *dd* on both Sides, fastened with Wood Screws, through which, and the Iron Tenons, Iron Pins pass, which are screwed fast with Nuts to the Staple. *Fig. 13. a Section of the End*

of

VENTILATORS. II

of two Ventilators at the circular End, laid on each other, shewing the Iron Rods *ff*, the Staples *gg*, and Ends of the Midribs *ee*.

247. THE upright Iron Rod *z*, *Fig. 2. Plate 1.* will work up and down very freely in a small Hole, in a square moveable Iron Plate, which moveable Iron Plate is covered with a somewhat larger hollow fixed Plate, with a wide Hole in it.

248. SOME work the small Ventilator, *Fig. 6. Plate 1.* by a long Lever parallel to the Midriff, one End of which is fixed at *R* to the Iron Rod *R, z.* the other End of this Lever reaching as far as to the other End of the Ventilator, and is supported by an upright Standard of Wood fixed on the Ventilator, at the Distance of about one third of its whole Length from *R*, whereby a like larger Ventilator may be worked with the greater Ease, *viz.* because the greatest Force, which is requisite for raising the Midriff, will be exerted, by pushing down the farther End of the Lever, which a Man can do with greater Ease than he can lift up the like Weight when he is in a stooping Posture.

249. *Numb. 16.* MENTION is made of the *Hessian Bellows*, or a Wheel in a Drum. The Defect and Deception of this Instrument lies in this, *viz.* that the Velocity and Force of the Air which is thrown out by the circulating Fans, is but in a very small Degree proportionate to the Velocity of the Fans, because the Force and Velocity of that Air is only equal to the centrifugal Velocity given by the circulating Fans, multiplied into so rare a Fluid as the Air is; which can be but little, and is in part abated by the Resistance of the stagnant outward Air. Whereas were Water thrown out by such an Engine, the centrifugal Velocity of so dense a Body as Water, would bear by thirty Times a much nearer Proportion to the Velocity of the circulating Fans, and the proportionate Resistance of the outer Air to the rushing-forth Water would be very inconsiderable. And farther, to confirm this Reasoning, suppose the Nose of the small Ventilators, *Fig. 6. Plate 1.* were fixed to the Nose of the Drum Bellows, and that both Engines were worked at the same Time, it is evident that the Air which is blown from the Ventilators, it having no other Way to retreat, would be superior to the Force of the Air from the Drum, which is no more than its centrifugal

VENTILATORS. 13

fugal Velocity multiplied into its very rare Substance; and consequently the Air in the Drum would be repelled to the Centre, &c. The contrary of which would be the Event, if the Force of the Air in the Drum, and consequently its Velocity, were greater than that of the Air from the Ventilators. And accordingly, on repeated Trials by several Ways, I found the Quantity and Force of the Air thrown out by the small Ventilators, *Fig. 6.* to be much greater than the Quantity of Air which was thrown out by a centrifugal Wheel, which was about seven Feet in Diameter, and about eighteen Inches wide: And withal, more Labour was required to turn the Wheel than to work the Ventilators.

250. As to Hospitals, where Ventilation is to be used with proper Caution, it may be well, especially in the Case of some Distempers, to draw the Bed-Curtains close, not only during the Ventilation, but also for a few Minutes after each Ventilation, *viz.* till the cool fresh Air is well warmed, and blended with the warm Air of the Room.

251. It is well known that the foul, putrid Air of Hospitals is a great Disadvantage to the
Patients;

Patients; and this not only consumptively-inclined Persons are sensible of, but also those who, otherwise in good Health, are put into Hospitals for broken Limbs, where they get the Hospital Distemper, which they would not have had in the purer Air of a private House; as do many also whose Disease requires their long Continuance there. Surgeons also observe, that Wounds do not heal so well in such foul putrid Air, as they will do in a purer Air. Whereas, if the Air of Hospitals were changed every Day, Morning and Evening, for a little Time, so as not to have Time to putrify, it is probable that many Patients would recover sooner, and that fewer would die in such purer Air; which would have this further Advantage, to make the Charity of Hospitals more extensively useful, by making Room for a quicker Succession of Patients.

252. THE first Trial of Ventilators in an Hospital, was made in the County Hospital at *Winchester*; where they are fixed under the Floor, at the farther End of the Ward from the Entrance, yet so as to be worked with great Ease by those in the Ward, by means of a Lever F, G, *Fig. 2. Plate 1.* fixed across the Ward between the Beds. The Midriffs
of

VENTILATORS. 15

of the Ventilators are each seven Feet long, and three Feet wide. The Ventilators are not separate, as in *Fig. 2.* but have only one common Partition of thick Plank. The Air is drawn out of the Ward through a large Trunk, which reaches near up to the Ceiling, that it may not incommode the Patients with the Velocity with which it rushes into the Trunk; which Velocity is so great, as to twirl fast round a little Wind-mill placed at the Mouth of the Trunk. And in Cases where such a Wind-mill cannot be seen by the Workers of the Ventilators, then the Wind-mill may be made to make a very small tinkling Bell to sound, as was done at *Newgate*, when the first Ventilators were worked by Hand, and as is done in *Durham County Goal*, with a very small Bell. The like twirling Wind-mill is found to be of considerable Use in diverting, and thereby encouraging those who work the Ventilators to persist in working; without which sensible Amusement they are apt to be discouraged from working the Ventilators; because, as it has been found by Experience, they are apt to look upon it as working to no Purpose, since they can see no visible Effect that it has on the invisible Air.

253. THIS Ward being filled with the Fumes of burning Pitch, they were drawn off, and dispelled by the Ventilators, through Trunks which conveyed them out into the open Air, in nine Minutes, notwithstanding the Length of the Ward is fifty-eight Feet, and its whole Capacity equal to 278 Tuns. When the farther Door was shut of another long Ward, which communicated with this by a long Passage, on working the Ventilators, the Smoke was drawn down the Chimney of that Ward; and with ten Minutes Ventilation the Ward was sensibly sweeter.

254. As to the Degrees of Refrigeration made thereby, Mr. *Pratt*, Apothecary, and Secretary to the Hospital, sent me the following Observations, made with *Fahrenheit's* mercurial Thermometer, which was graduated like that described *Numb. 197.* which was hung on the Bed next to the open Door of the Ward, till the Mercury was got to a settled Point; when, on working the Ventilators, the Difference was, *viz.*

December

VENTILATORS. 17

December 24.

External Air above freezing	4 Deg.
In the Ward - - -	18
After ventilating 5 Minutes	17
10 Minutes	15
15 Minutes	15

December 26.

External Air - - -	6
In the Ward - - -	19
After 5 Minutes Ventilation	18
10 Minutes - - -	17
15 Minutes - - -	16
20 Minutes - - -	15½

December 28.

External Air into freezing -	2
In the Ward above freezing	12
After 5 Minutes Ventilation	11
10 Minutes - - -	10
15 Minutes - - -	9 { or something more.
20 Minutes - - -	8½

Hence we may observe, that when, *Dec. 28.* the external Air was so cold as to be 2 Deg. into freezing, and the Air in the Ward 12, that on 20 Minutes Ventilation the Air of the Ward was refrigerated $3 + \frac{1}{2}$ Degrees, *viz.* to $8 + \frac{1}{2}$. And farther in the Ward from the Door, the

Refrigeration was less, and in warm Weather the Refrigeration by Ventilation will be much less: The Degrees of Ventilation must therefore be more or less in proportion to the different Temperature of the Air as to Warmth or Coldness, Moisture or Driness, which will be best determined by Experience. The two principal Times of Ventilation should probably be Mornings, and Evenings before the Dew falls; the first to carry off the frowzy Air of the whole preceding Night, the latter to supply the Ward with Store of fresh Air for the Service of the Night. Ventilation will not only be of use to the Patients in many Respects, but will also be very beneficial to the Physicians, Surgeons, Apothecaries, and Nurses, who attend them. During Ventilation, all or some of the Bed-curtains may be drawn, especially in some Diseases, and during the colder Constitution of the Air. This is what is practised in some Hospitals, when Windows are set open to air them.

255. THERE are Ventilators also in *St. George's Hospital*, near *Hyde-Park-Corner*, whose Midriffs are each nine Feet long, and four and a half Feet wide. They are fixed on the Top of the House, and are worked by a
 I Wind

VENTILATORS. 19

Wind-mill. From the Ventilators there goes a Trunk, a Foot square in the Clear, to the three large Wards on the western Side of the Hospital, which are over each other, and extend North and South. From the above mentioned perpendicular Trunk, there is near the Cieling of each Ward a like Trunk, which reaches from near the Door of the Ward to the farther End of it, *viz.* about Seventy-five Feet; where the foul Air being drawn into the Trunk, the succeeding fresh Air enters at the Ward-door, and thereby drives out the foul Air before it; and the like Trunks are fixed in the Wards on the eastern Side of the Hospital. But the fresh Air must by no means enter at the Windows in cold Weather, because such cool Air will fall precipitately down thro' the warmer Air of the Ward, and thereby greatly incommode the Patients; whereas by entering principally at the lower Part of the open Door-case, that Inconvenience will be avoided; Or Holes might be made thro' the Wall, for the Air to enter the Wards from the Stair-case; by which means the foul Air at that End of the Ward will be drawn to the other End of the Ward, and thence be drawn off by the Ventilators. The Doors should be always open while the Ven-

tilators are working. There are also Air-trunks to several lesser Wards, as also to a foul Ward.

256. As several of these Wards may thus be ventilated at the same Time, and as the Change of Air will therefore be so very gentle as to be in a manner insensible; therefore the Ventilation may be continued much the longer, with great Safety to the Patients.

257. SOME are apt to think Ventilators useless in Hospitals, because they can in good warm Weather air the Wards by opening the Windows, and that doubtless much better than by Ventilation; and were there such good kindly Weather all the Year round, then Ventilators would be useless. But since, for the greatest Part of the Year, the external Air is too cold to be admitted in at Windows, because it is a well-known Truth, *viz.* that cold Air admitted into the upper Part of a warm Room, being specifically heavier, falls precipitately down thro' the warmer Air. And this it must doubtless do in the warm Wards of an Hospital, so as to incommode and endanger the Welfare of the Patients; besides that, the Indraft of Air at open Windows will
be

VENTILATORS. 21

be much greater than what comes in by the more gentle Method of Ventilation: Besides this further great Advantage, that the fresh Air drawn in by Ventilators, principally enters the Wards at the lower Half of open Door-cases, as is plain to be seen by holding a lighted Candle at the lower and upper Parts of an open Door-case; or else the fresh Air may be conveyed into some Wards, by Trunks placed near the Floor, as is done with good Effect in 32 Chambers in the Small-Pox Hospital at Sir *John Oldcastle's*. It has been said, that some Hospitals stand in so open and airy a Situation, that they have no Occasion for Ventilators; yet it is well known, that notwithstanding Ships at Sea are in so airy a Situation, that Millions of People have lost their Lives there by the Foulness and Putridness of the Air in Ships; which Inconvenience is effectually prevented by Ventilators, as is now fully proved by repeated Experience in many Ships, which the People on board are so sensible of, that they work the Ventilators with Eagerness.

258. THERE are Ventilators also fixed in the County Hospital at *Northampton*, which ventilate three Wards over each other: they

are fixed to the Cieling of the middle Ward to save Room, and are worked in the upper Ward by a Bed-side. They are fourteen Inches deep in the Clear within, and their Midribs six Feet long, and three Feet nine Inches wide. They have not wanted any repairing in ten Years, tho' worked constantly three or five times a Day.

259. THE lower Ward contains 125 Tuns of Air, the middle Ward 313, and the upper Ward about 230 Tuns. Small twirling Wind-mills may be fixed in each Ward, where the Air is drawn into the respective Trunks of the Ventilators; which are found to be of use, not only to divert and amuse those who work the Ventilators, but also to let the Patients in each Ward know that they have their due Proportion of Ventilation.

260. THE Ventilators are fixed in an Hospital at *Bristol* in a different Manner from any of the above mentioned, *viz.* one of the large Ventilators, *Fig. 2.* is placed in an inverted Position directly over the other, leaving a void Space between them of about 20 Inches Depth; in which Position the Iron Rods R, z, are worked up and down by a Winch, which has two crooked Cranks in its Axil,
to

VENTILATORS. 23

to which the Rods are fixed. But as by this means the Motion of the Rods is very oblique, it was therefore necessary to have the Holes at *zz* very large, and consequently requisite to have leathern Bags nailed round the Holes *zz* at one End, and tied to the Bars at the other End. This Manner of fixing Ventilators may be commodious in Places where there is not convenient Room for the other Manner of placing and working them; but then they require somewhat the greater Force to work them, on account of the great Obliquity of the Rods.

261. IN the Year 1752, a Pair of double Ventilators were put into an Hospital for the Small-Pox at Sir *John Oldcastle's*, near *London*. Their Midribs were seven Feet long, and three Feet wide. The House was four Stories high, with Galleries on every Floor, on each Side of which were four Chambers, with vacant Spaces in the Middle, in which there was a Chimney. In the Middle of one of these Galleries the Ventilators were fixed up to the Cieling, where the Lever was commodiously worked up and down by means of long Iron Rods fixed to it at *F* and *G*, *Fig. 2*, the lower Ends of which Rods were fixed to short

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Levers,

Levers, one End of which worked on Iron Pins fixed in the Sides of the vacant Space where the Chimney was. By means of Trunks branching from the larger perpendicular ones, all the thirty-two Chambers were ventilated in their Turns, *viz.* the eight Rooms of a Gallery at a Time, by having the foul Air drawn with a cautious Hand thro' a Hole four Inches square, near the Cieling of each Room, in which were two Patients, the fresh Air entering thro' a long Trunk under the Bed on the other Side of the Room; which Trunk is full of small Holes, especially at its farther End, thereby not only to prevent the Inconvenience of a large Stream of Air in one Place, but also to convey some of the fresh Air to the farther Side of the Room, and by that means impel all the foul Air so as to have it drawn out. The foul Air is conveyed by a Trunk thro' the Roof of the House, in a Valley, where the upper Part of the Trunk is turned horizontally, to prevent the Entrance of Rain. In case it may not be proper to ventilate any particular Wards, there is a Valve to prevent the drawing out of any Air. The Midriffs were seven Feet long, and three wide. There are now many more Chambers aired by
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the same Ventilators. This is no Annoyance to the Neighbourhood.

262. THIS Ventilation causes the Hospital to be in a manner as sweet as a private House. And it is observed, that fewer by more than one Third die, since the drawing the foul putrid Air out of the Chambers by Ventilation; and it is reasonable to think, that the Danger of so putrid a Distemper as the Small-Pox is, will be much greater in a foul putrid, than in a purer Air. The good Effect of this Method, will probably lead to the not keeping the Chambers of the Sick very close in private Houses.

262. As Ventilators were first fixed in *Winchester* Hospital, so were they first used in that Goal, which are found to be of great Benefit to the Prisoners, in freeing them from the intolerable Stench of a foul, close, putrid Air, by often drawing it off, and introducing fresh Air. They are fixed up to the Cieling of the Debtors Room, as well that they may be out of the Reach of the Prisoners to damage them, as also that they may take up none of their Room; where they are worked by the Lever F, G, which is placed near a Wall, thereby
venti-

ventilating both the Debtors Room and the Criminals Dungeon, or Night-Room. The Prisoners enjoyed good Health for more than two Years after they were fixed there, *viz.* till two Fellows from *Reading Goal*, who had the Goal Distemper, first gave it to a Man who shaved them; and some time after eight more were seized with it, who were all in the same Day-Room, in which the Felons had been till they were executed; and no more than those eight were ill of that Distemper for a long Time after: An evident Proof, that the Felons brought the Distemper there. The Goal Distemper is of so infectious and pestilent a Nature, that it is well known, by many Instances, to have been carried a great Way in the fresh open Air; and may well therefore infect in close Prisons, notwithstanding the Wards are ventilated to such a Degree, as very sensibly to refresh them. Yet it is very probable that the like Degree of Ventilation, might effectually prevent the Breeding of Goal Distempers, which are chiefly occasioned by a high Degree of Putrefaction of foul, long-confined, stagnant Air. Thus Silk-Worms are destroyed by their own Stench.

VENTILATORS. 27

263. IT were therefore to be wished, that the Prisoners which are removed from un-ventilated Goals, to those which have Ventilators, were carefully kept in separate Wards, till Ventilators are put into all Goals. For, tho' Ventilation will effectually prevent the first Breeding of the Goal-Distemper, yet it will not cure it, nor prevent its spreading Infection. Which shews how reasonable it is to have all Goals thus ventilated, thereby to prevent the Breeding of that pestilential infectious Disease, called the Goal-Distemper.

264. MANY are apt to think, that there is no Occasion for Ventilators in those Prisons, which have an open Area or Court, for the Prisoners to air themselves in. But this is a great Mistake : For there are many Instances of the Goal-Distemper's being bred, and destroying many in Goals with open Courts. This was frequently the Case in the *Savoy*, before Ventilators were fixed there to change the foul putrid Air of the Wards. And in the *Fleet* Prison an hundred died of that Distemper in the Winter, between the Years 1753 and 1754, notwithstanding there is a large Area. And it is notorious, that Millions of Mankind have been destroyed by the noxi-
ous

ous putrid Air in Ships, and this notwithstanding they have the Advantage of Plenty of very pure Air to breathe in, whenever they come upon the open Deck. These daily Instances fully prove the great Importance of refreshing the foul Air in Prisons, Ships, &c.

265. DR. *Pringle*, in his ingenious *Observations of the Nature and Cure of Hospital and Goal Fevers*, says, ‘ That there is no Security from the Distemper at Trials, tho’ none of the Prisoners are actually ill of the Distemper ; for, besides that it may be in the Blood for some Time, without any apparent Symptoms ; even in an healthful State, the Danger is little less, from the Cloaths.’ Which he proposes to have burnt.

266. By Order of the Right Hon. *Henry Fox*, Esq; Secretary at War, Ventilators are fixed under a Guard-bed in the *Savoy*, whose Midribs are eight Feet long, and five Feet broad ; with these, five Rooms are ventilated ; three always, and sometimes four at a Time. The Air-Pipes draw Air from under the Guard-beds ; Grate-work Passages being made thro’ the Fore-front of the Beds, at

VENTILATORS. 29

an oblique distant Position from the Mouth of the Pipes, thereby to prevent the Indraft of any Thing the Soldiers may out of Diversion put there. And, for the same Reason, one of the Air-Pipes which goes down thro' the Boards of the Floor to a Room below, does not go directly thro' the Cieling, which is opened at about two Yards Distance from the Air-Pipe.

267. MR. *Hayward*, Master of the *Savoy* Prison, has always been very careful to have the Wards scraped and swept every Morning ; for he observes that the Dirt of their Shoes much increases the Stench and Foulness of the Air. Yet, notwithstanding this his Care to keep the Rooms clean, when there were many Prisoners, they were apt to be sickly, and to get the Goal-Distemper, for want of changing the foul, stagnant, putrid Air. The doing of which, by means of Ventilators, has made those Wards so healthy, that in the Year 1749, of 200 Men but one died, and he of the Small-Pox. And in the Year 1750, of 240 which were there three Months, but two died. In the Year 1751, none died : And, in the Year 1752, only one old Person died. Whereas, before the Ventilators were
put

put up, there often died 50 or 100 of the infectious Goal-Distemper. And this, notwithstanding they have a paved open Court to walk in, which was washed thrice a Week in the Evening, and the Wards as often in the Morning in warm Weather, and every 14 or 20 Days in cold damp Weather. But, before Ventilation, the foul Air of the Wards, which became putrid by long Continuance, being not frequently changed for fresh Air, was infectious and deadly. This probably occasioned the Goal-Distemper there in the Year 1757; one of the large Wards having no Ventilation, whence the Infection might spread. And what contributes the more to the present Healthiness of the Place, is, that Mr. *Hayward*, the Master of the Prison, continues with the same Care and Zeal to keep it clean. And, the more effectually to cure the Wards of any Infection, he burns, as I desired him, every six Weeks, two Pounds of Brimstone in the larger Wards, and a Pound in the smaller Wards. And Mr. *Akerman*, the Keeper, informed me that the Wards in *Newgate* are cleaned every Week; a laudable Example that ought to be practised in Goals; but one of the Wards having no Ventilators, and the Place being crowded with Men, the

Goals

VENTILATORS. 31

Goal-Distemper was bred in the very hot Summer of the Year 1757, which was prevented from spreading, by removing the Sick, and purifying the Wards with the Fumes of burning Brimstone and Vinegar. If some Trunks were put up for the foul, hot, light Air, to pass off thro' the Roof, it would probably be an effectual Means to prevent that pestilential destructive Distemper from Breeding.

268. VENTILATORS were fixed in *Newgate*, by Order of Sir *Richard Hoare* when Lord-Mayor, which ventilated five principal Wards where the Women were. It was observable that the Prisoners were more healthy, and considerably fewer of them died, for a Year, during which those Wards were ventilated; which are but Part of the Apartments, in which there are often a great Number of Prisoners. And the greatest Part of those died, when many sickly Prisoners were brought from other Goals to *Newgate*, to attend the Sessions.

269. BUT as this salutary Ventilation, in *Newgate*, with Mens Hands, was afterwards neglected, in the Year 1752, in the Mayoralty

alty of Mr. Alderman *Winterbottom*, the Lord-Mayor and Aldermen came to a Resolution to have much larger Ventilators fixed in *Newgate*, to be worked by a Wind-mill. An Affair which I had much at Heart, as being a laudable Example, not only to the rest of the Nation, but also to other Nations, particularly *France*, where the Duke *de Noailles* desired me, by his Librarian *Monf. Mazeas*, of the Society of *Navarre*, and F. R. S. to send him an Account how it was done; that as far as in him lay, he might promote the having the same done in the Prisons of *France*.

270. *bb*, (*Fig. 19.*) the Midribs of the Ventilators are each nine Feet long, and four and a half wide. Two Pair of these Ventilators are laid on each other, (as in *Fig. 13.*) *abcd*. The Midribs of both Ventilators are moved up and down by the flat Iron Rods *ef*, which have a Joint at *f*, where they are fixed to the Midribs, then passing thro' the upper Part of the lower Ventilator, and thro' the Bottom of the upper Ventilator, and also thro' an Iron Plate at *z*, about three Inches square; this Plate to be covered by another broader Iron Plate, which is to be
screwed

VENTILATORS. 33

screwed fast to the Bottom of the upper Ventilator: This upper Plate has a wide Hole in its Middle, to give room for the Iron Rod at *g* to move sideways to and fro, with the under Plate, the Hole of which exactly fits the Iron Rod, by which means no Air can escape at *g*; and the like Plates are at *i*, which is the Top of the Ventilator: At *f g*, are Joints, where the Iron Rods are fixed to the Midriffs; by this means both Midriffs are moved up and down at the same Time. And the Iron Rods of both Sides of the Ventilators being fixed to one common Lever at *e e*, all the four Midriffs are thereby alternately worked up and down at the same Time.

270. THE circular Ends of the Ventilators, as well as all other Parts, are fastened with Wood Screws dawbed with Grease to prevent their rusting in the Wood, so that any Part can be taken off commodiously, to rectify any Failure in them.

271. *vvvv xxxx* are the Valve-holes, which are 23 Inches long, and six and a half Inches wide. The Valves are covered with Buckram glued on them, for their greater Strength; and if some Linseed-oil is mixed

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with the Glue, it will prevent its softening with moist Air. The Valves move on Lifts of tann'd Sheepskin, and fall on Lifts of woollen Cloth nailed round the Valve-holes, to break the Force of their Fall, and better to prevent the Escape of the Air.

272. A VERY large Nose, (*Fig. 20.*) is fixed with Iron Hooks *k k* to the Ventilators *l l*, which Nose is divided into three Spaces. The middle or largest of these Spaces, *m m*, receives all the foul Air which is blown into it, from the eight middle Valves *x x x x*, (*Fig. 19.*) whence it passes through a Trunk *t t*, sixteen Inches wide, up through the Leads of *Newgate*, into the open Air. The Top of this Trunk is covered with Weatherboards to keep the Rain out; the middle Valves *x x x x* hang so as to open outwards.

273. THE two other outer Spaces or Partitions of the Nose *p p*, receive the foul Air, which is drawn into them, from the several Wards, through the Trunks *p p*, and passes off into the Ventilators, through the eight outer Valve-holes, *v v v v*, (*Fig. 19.*) whose Valves are hung so as to open inwards.

VENTILATORS. 35

274. As the several branching Trunks are to be opened and shut, as it shall be found proper to ventilate or not ventilate the several Wards in their Turns; so, in order to prevent the Spoiling the Midribs of the Ventilators, for want of Supply of Air, when all the Trunks may happen to be closed, it was therefore requisite to have two Holes cut in the outer Nostrils or Partitions of the Nose, at *z z*, (*Fig. 20.*) each Hole to be 18 Inches long, and 10 Inches broad or high, and 12 Inches deep, and to have these Holes covered with Boxes, 20 Inches long, and 14 Inches wide, to be fastened with sliding Fillets like Drawers. The Bottom of each of these Boxes to be a large moveable Valve, opening upwards, and towards the Ventilators. These may be called sniffing Valves, because they are to be made of such a Weight, as to open only when all the Trunks to the several Wards are shut; whereby the Ventilators will always be supplied with Air, so as not to endanger the Breaking the Midribs for want of it.

275. AND in order the better to strengthen the head cross Rail of the Midribs, that they may not be broken by the quick Jerks of the Crank of the Windmill, when it turns fast,

a strong iron Plate is fixed to that Rail, and for the same Reason the Iron Axle-tree at the other Hinge-end of the Midriffs is fix'd with Clams or Claws to the Ends of the long Rail.

276. THE Lever which moves the Midriffs up and down is strong, and fourteen Feet long, that the Ventilators may the more easily be worked by Men, if needful in long calm Weather.

277. A Weight equal to the Weight of the Iron Rod, which reaches from the Crank of the Mill's Axle-tree, down to one Arm of the Lever of the Ventilators, is fixed on the opposite Arm, thereby to take off the Resistance of the Weight of that Iron Rod to the Motion of the Mill.

278. THE Ventilators are about 18 Inches deep in the Clear, thereby to allow for the Thickness of the Midriffs; and that they may not strike against the Top and Bottom of the Ventilators, which would spoil them.

VENTILATORS. 37

279. THESE Ventilators are fixed in an upper Room of *Newgate*, in order to be near the Windmill on the Leads, which works them. From each of the outer Nostrils there goes a Trunk, which are 12 Inches in the Clear within-side; these Trunks pass along on each Side of the open Area over the Gate-way, but at some Distance from the Sides of the Area. And then descend through all the Floors as far as a little below the Cieling of the Ground-Rooms; and are covered with plate Iron within the Reach of the Prisoners.

280. FROM these descending Trunks, lesser Trunks, six Inches square within, branch off near the Cieling of every Room. These branching Trunks may be larger or smaller, according to the different Sizes of the Wards, and also in proportion to the greater or lesser Numbers of Prisoners that are usually there.

281. THESE branching Trunks are to extend more or less into the several Wards, in such manner, that when the foul Air is drawn out of any Ward, the fresh Air may enter on the opposite Side; and by that means drive all the foul Air out before it. And in case

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there are several Inlets for fresh Air on opposite Sides of the same Ward, then the Trunk reaches to the Middle of the Cieling of such Ward.

282. And that many Wards may be ventilated at the same Time, there are sliding Shutters with long Handles, which slide up and down in Staples; in order not only to ventilate several Wards at a Time, by partly closing the side Trunks; but also wholly to shut up the Trunks of some Wards, while others are ventilating. The Handles of these Sliders are locked fast, that it may not be in the Power of the Prisoners to shut or open them. In order to find out in what Proportion to close with sliding Shutters the Trunks of the several Wards that are to be ventilated at the same Time, it will be needful at first to tie a lighted Candle at the End of a Pole, and hold it at the Mouths of the Trunks, thereby to make some Estimate of the Quantity of foul Air that is drawn into the several Trunks.

283. AND when the upper Floors are ventilating, the Air is hindered from being drawn out of the lower Floors, either by
shut-

shutting all their Trunks, or by a sliding Iron, which shuts the descending Trunk, near the Floor of the lowest of the Rooms that are ventilated. But when the Wards of the lower Floors are to be ventilated, then all the Side-branching Trunks of the upper Floors are to be shut, that the whole Effect of Ventilation may be in the Wards of the lower Floors.

284. By this means, all the Wards may be ventilated in their Turns, in such Proportion as shall by Experience be found most convenient.

285. ALL these sliding Shutters have large Figures, *viz.* 1, 2, 3, &c. painted on them; that by these Numbers they may more easily be described, and referred to, in the several Directions for ventilating the several Wards.

286. IN the Case of a Prison that is built with an open Area or Court in the Middle; the Side of the Prison which is opposite to the Side where the Ventilators are, may commodiously be ventilated in its Turn, by having a round brick Air-gutter under-ground,

D 4 through

through which the foul Air of those Wards may easily be drawn.

287. IN lesser Prisons the Ventilators need be but one half of these in *Newgate*, which may easily be worked by men; as is found by Experience in several Prisons and Hospitals.

A Description of the Windmill, which is fixed on Newgate to work the Ventilators; Plate IV. Fig. 21.

288. As this Mill is designed and contrived to move with a small Degree of Wind, and withal to obtain a sufficient Power in a small Compass, I thought it requisite to give a Draught and Description of it. *Fig. 21. c.* is one of the Cross-trees which support the Mill-post *d*, and the Spurs or Braces *ee*; which Cross-trees rest on the Blocks *a*, where they are fixed to the Floor they stand on, by strong Iron Bolts, screwed fast under the Floor. *b*, the Crown-tree, to steady the Iron Rod that passes there through Brass Collars, which are contrived so as to screw closer together as they wear away. *d* is the main oaken Post, which is bored hollow for the
Iron

VENTILATORS. 41

Iron Rod *b* to pass through from the Crank of the Iron Axle-tree *i*. *f* is the Girdle on which the turning Frame *g n* moves; on this Girdle lies a broad circular Iron Plate, on which the Brass Friction-wheels have their Bearing, and these Wheels are so placed at different Distances as to turn on different Parts of the Plate, and thereby save its wearing all in one Circle. These Wheels are three Quarters of an Inch thick, and five and half Inches in Diameter; their Iron Axle-trees are an Inch thick, and move in Brass Collars. *g, n*, is the turning Frame which carries the Axle-tree *i i*, and the Sails *l k*, which are turned so as always to face the Wind, by the Vane *b*. *q r*, the double pricked Lines, are Iron Braces, which are fastened at each End with Iron screw Bolts to keep the Frame from wracking. *x* is the Crank, which is six and half Inches long, and therefore gives a Stroke of thirteen Inches: but the lower End of the Iron Rod *x* is fixed to the Lever of the Ventilator, *Fig. 19.* at such a Distance from the Centre of its Motion, as to raise and fall the Midribs fifteen Inches; there are Brass Collars at the Joining of the Iron Rod to the Crank, and also at the Bearings of the Axle-tree, which Collars are screwed nearer and nearer

as

as they wear away. The Iron Axle-tree extends forward about two Feet and half beyond the Face of the Sails, from the Extremity of which, *s*, eight Iron Braces *ll*, go to each Arm, to which they are fastened by Iron screw Bolts, which bind them and the Iron Circle of pricked Lines *mm*, in *Fig. 22.* fast together; the Diameter of this Iron Circle is six Feet. The Sweeps or Arms of the Mill *kk* are seven Feet three Inches long. They are morticed into the Knave or Drum *yy*. And as an Angle of 55 Degrees is found, both by mathematical Calculations and by Experience, with a small Windmill placed before the Nose of my Ventilators, to be the Degree of Weathering, as Millwrights call it, or the Angle or oblique Position of the Sail to the Wind, for obtaining the greater Force, so an Angle near that, *viz.* of 60 Degrees, has been found by Experience of the right honourable the Earl of *Northumberland*, as he informed me, to do very well in such small Mills. But in common Mills, with very long Arms, the Obliquity of the Sails ought to be less; else their great Velocity will, in strong Winds, cause a counter-acting Force at the Back of the Sails. In order to avoid this Inconvenience Mr. *Cowper* very rightly proposed, not to fill up the whole
 Space

VENTILATORS. 43

Space with Sails, but to leave a void Space of about six Inches Breadth between the Sails, as is represented in the Sails *mm*, *Fig. 22.* that the direct Current of the Wind, as it passed through there, might carry along with it, and give a Turn to the Course of the Wind, which else, being drove obliquely from the Face of the preceding Sail, would thereby be drove to act on the Back of the following Sail, and thereby abate the Force and retard the Motion of the Mill.

289. *n* (*Fig. 21.*) is the Brake-pole; and the single pricked Line *t* at the End of it, is the Sword which is to clasp round the Nave to stop the Mill, by pulling the Rope *w* which is expressed by the scroll Line. *oo* is the Bottom Shere-tree of the Turning-frame. *p* expresses the Manner of screwing the Brass Collars of the Axle-tree nearer and nearer as they wear away.

290. MR. BAILY has contrived to prevent a Corn Mill from going too fast, and more equably, by a fixed Sail, like an Apron, fastened in Front under the Axle-tree, and acting on a Lever of great Purchase, so as to press on the Friction-wheel, by a small Roller greased,

greased, in proportion to the Strength of the Wind.

291. THE Noxiousness of the putrid Air in unventilated Goals, may be seen in the following Account, which was drawn up by Dr. Pringle, viz.

An Account of several Persons seized with the Goal Fever, by working in Newgate, and of the Manner by which the Infection was communicated to one entire Family.

292. HAVING lately had an Opportunity of seeing several Cases of the true Goal Fever arising from the Goal itself, I thought it would not be improper to lay before the Society a short Account of the Manner in which those Persons were seized; the chief Symptoms and Progress of the Disease, with some Remarks upon it, in order further to illustrate what I have advanced * elsewhere, concerning the Danger arising from foul Air, and the Agreement of this Distemper with what has been called the Fever of the Hospital, or more generally, a malignant or pestilential Fever.

293.

* Observations on the Diseases of the Army.

VENTILATORS. 45

293. IN the Month of *October* 1750, a Committee of the Court of Aldermen was appointed to enquire into the best Means for procuring in *Newgate* such a Purity of Air, as might prevent the Rise of those infectious Distempers, which not only had been destructive to the Prisoners themselves, but dangerous to others, who had any Communication with them, and particularly to the Courts of Justice upon the Trial of Malefactors, whereof a fatal Instance had occurred that Year at the Sessions held in the *Old-Bailey*.

294. THE Rev. Dr. *Hales* and I being consulted by the Committee upon the Point referred to them, and having visited the Goal in Company with those Gentlemen, it was then agreed that, considering the Smalness of the Place, in proportion to the Number of the Prisoners, it would be proper to make a farther Trial of the Ventilator, and to have it worked by a Machine in the Manner of a Windmill, to be erected for that Purpose upon the Leads of *Newgate*.

295. THE Scheme was laid before the Court of Aldermen and approved of, but not
7 put

put in Execution till near two Years after. For on the 11th of *July* 1752, Dr. *Hales* acquainted Dr. *Knight* and me, that several of the Tubes were finished, and that the Machine had been going about six Weeks; wherefore being desirous to see the Effects, he had appointed Mr. *Stibbs*, the Carpenter employed in that Work, to meet him at *Newgate*, and desired us to go along with him.— We went accordingly, and having visited several of the Wards, we were all of us very sensible, that such as were provided with ventilating Tubes, were much less offensive than the rest that wanted them; and Dr. *Hales* and I could perceive a considerable Improvement made upon the Air of the whole Goal since the Time we had been first there with the Committee. Some of the Wards were so free from any Smell peculiar to such Places, that I am persuaded, were Dr. *Hales's* Design compleated, and a Person appointed to regulate the Sliders of the Tubes, and to keep the Machine in order, the usual bad Consequences from foul and crowded Goals, might in a great measure, if not wholly, be prevented in that Place.

VENTILATORS. 47

296. ONE of the Wards allotted for the Women, had a small Room adjoining to it, in which they usually slept. Both Places seemed at that Time well aired, though the latter was close, and, if I mistake not, without either Window or Chimney. The Prisoners informed us, that before this Ward received the Tubes, this sleeping Place had been very offensive, but that soon after it became sweet; and though upon the first Working of the Ventilator they had been more sickly than before, they soon recovered their Health, and had preserved it ever since. Now from this Account we must not infer that any Danger will arise from a sudden Change of bad Air for good, since this Accident may be better accounted for, from another Circumstance we were then likewise told of, *viz.* that this Ward of the Women had been supply'd by a ventilating Tube before those in the lower Story, where the Air being in a more corrupted State, it had passed from thence through the Seams of the Floor, and other Passages, to replace that which was drawn off by the Tube in the Ward above: but that after the bad Air was exhausted, the Benefit of the fresh Air soon appeared by the better Health of the Prisoners.

297. BUT as it was not my Design in this Paper to set forth all the Advantages that may be expected from the Ventilator, I shall leave that Subject to be treated of by the Inventor of it, and shall only take notice, that the Tubes from the several Wards, uniting in one great Trunk, convey all the putrid Steams by that Channel into the Atmosphere, through a Vent made in the Leads of *Newgate*.— Though the Wind was moderate during the Time we staid, yet we observed that the Ventilator threw out a considerable Stream of Air of a most offensive Smell.

298. BEFORE we parted, Mr. *Stibbs* informed us, that *Clayton Hand*, one of his Journeymen, whilst he was employed in setting up the Tubes, was seized with a Fever, and carried to St. *Thomas's* Hospital, after lying some Days ill at his own House; whereupon apprehending that this Man's Sickness might be owing to the Air of the Goal, and Dr. *Knight* and I having the Curiosity a few Days after to go to St. *Thomas's* to make the Enquiry, we found the Patient sitting in one of the Courts, recovered of his Fever, though still weak, and had the following Account from himself.

V E N T I L A T O R S. 49

299. HE said, that upon first finding himself indisposed, he had left off Work for some Days, but upon growing better he had returned to *Newgate*. That soon after happening to open one of the Tubes of the old Ventilator, which had stood there for three or four Years, such an offensive Smell issued from it, that being immediately seized with a *Nausea* and sickness at his Stomach, he was obliged to go home, and that the Night after he fell into a Fever, in which he lay about eight Days before his Friends carried him to the Hospital. That becoming soon delirious, he recollected no other Symptom succeeding those mentioned, besides frequent *retchings* to vomit, a trembling of his Hands, and a constant Pain in his Head. This Man had taken no Medicine before he came into St. *Thomas's*, and since that Time was attended by Dr. *Reeves*; but as that Gentleman was not then present, we were informed by the Apothecary, that *Clayton Hand* had been admitted in the advanced State of a continued Fever, attended with a great *Stupor* and a sunk Pulse, and that the Fever had not left him till several Days after his Admission.—The Nurses Account was, that he had all along lain like one stupified, and that after

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the Fever went off, he had continued for some time very dull of Hearing. We could learn nothing certain about the Duration of the Fever, but from what the Patient and his Attendants told us, we collected that he must have been ill between two and three Weeks. So that from all these Marks we made little Doubt but this Person had been ill of the true Goal Distemper, and were confirmed in our Opinion by the following Circumstance.

300. IN Company with the Convalescent was one *Thomas Wilmot*, another of Mr. *Stibbs's* Journeymen, who had likewise worked in *Newgate*, and whom we remember'd a few Days before to have seen in that Place, very active and in perfect Health. This Man told us, he had come to see his Companion, but as he apprehended himself in Danger of falling into the same Fever, he should therefore be glad of our Advice. Upon Examination we found his Tongue white, his Pulse quick, and that he complain'd of a Pain and Confusion of his Head, with a Shaking of his Hands, and a Weakness of his Limbs. He said his Disorder had come on gradually since the Time we saw him in *Newgate*, but that

VENTILATORS. 51

that he was then so very ill he could work no longer. From which Account it appear'd to us, that this Man had also catch'd the Infection, but as the Fever seem'd not to be quite formed, we had hopes of stopping its Progress: and with this View we advis'd him to take a Vomit, and on the following Night a Sudorific. He followed the Prescription, and the Effects shall afterwards be mentioned.

301. AFTER *Wilmot* had told us his own Case, he inform'd us of the Indisposition of three more of his Companions, who had all been employ'd by Mr. *Stibbs* in *Newgate*: Whereupon we took their Directions, visit'd them, and found them all ill of the Goal Distemper.

302. THE first was *Michael Sewel*, who lodg'd in the *Swan-Yard*, near *Newgate*. This Man had been ten Days confin'd to his Bed, without taking any Medicine. He was then delirious, and had the petechial Eruption: But observing that he lay in a close ill-aired and dirty Room, without any Attendants but his Wife, then suckling a Child, we believ'd he had no chance to recover where he was,

and therefore recommended his Case to Mr. *Stibbs*, who procured his Admission that Day into *St. Thomas's Hospital*, where he also recovered.

303. THE second was *Adam Chaddocks*, who lay at a Green-shop in the *Little Old Baily*. He was taken ill on the same Day with the former, and had used no Medicine. He had likewise the petechial Spots upon his Breast and Back, and though he was not altogether insensible, was affected with a *Stupor*, attended with a sunk Pulse, and other Symptoms of the Distemper. His Landlady, who took care of him, informed us, he had been troubled with *Reachings* to vomit, and a Head-ach from the Beginning, and that for some Days past, he had been seized with a Looseness, and that his Stools were very offensive. As the Room this Person lay in was large and well air'd, we did not think it necessary to remove him, but recommended him to the Care of Dr. *Pate*, Physician of *St. Bartholomew's Hospital*, who attended him till he recovered.

304. THE third was *John Dobie*, Apprentice to Mr. *Stibbs*, and about 15 Years old,

VENTILATORS. 53

old, who lived with his Parents in a Court by the *White Bear* in *Cannon-street*. We saw him on the same Day with the other two, which was the 14th of his Sickness, and the 12th since he took to his Bed. His Mother told us, that some of the Journeymen working in *Newgate* had forced him to go down into the great Trunk of the Ventilator, in order to bring up a Wig one of them had thrown into it; and that as the Machine was then working, he had almost died of the Stink before they could get him up. That upon coming home, he complained of a violent Head-ach, a great Disorder at his Stomach, with Reachings to vomit, which had never entirely left him. We found him extremely low, with a sunk Pulse, a Delirium, and an unusual *Anxiety* or Oppression about his Breast. This last Symptom we ascribed to the Opiates he was then taking for a Looseness that had come on two or three Days before we saw him. This Lad being in no Condition to be moved, and being besides well attended by his Mother, and in a well aired Chamber, we prescribed to him there, and repeated our Visits till he was quite free of the Fever. It was observable, that before he was taken ill he had been twice let down

into the great Trunk of the Ventilator, when the Machine was standing still, without complaining of any ill Smell, or receiving any Hurt thereby, but that the last Time, when the Machine was working, he immediately cried out, he was ready to be suffocated, and the two Men who helped him out, by receiving the foul Steam from the Trunk, were both set a vomiting so violently as to bring up Blood.

305. ON the 23d of *August*, *Thomas Wilmot* above-mentioned, called upon *Dr. Knight*, and told him, that after taking the Vomit and Sweats, he had immediately recovered, but begged him to see his Wife, who then lay ill of a Fever at his House in *Snow's-fields, Southwark*. The Doctor suspecting that this Woman's Indisposition might be owing to the Contagion received from her Husband, acquainted me with it, and carried me to see her. There we were informed that *Wilmot's* Daughter, a Girl of eight Years old, who lay with her Parents, had been seized with a Fever soon after her Father's Recovery; that she had been ill about a Fortnight, and they believed had Spots upon her Breast, but that she had recover'd without any Medicine.

That

That her Mother had not only nursed her, but continued to lie with her, and that some time after the Girl's Recovery, the Mother began to complain, and soon after fell into a Fever, and that it was the 12th Day since she was confined to her Bed. This Woman having the *Petechiæ*, a Stupor with Deafness, and a sunk Pulse, there was no Doubt of her being likewise infected with the Distemper, and probably by her Daughter. As she had been without any Assistance, we advised her Husband to send for Mr. *Breach*, Apothecary in the *Borough*, who having served in the Hospital of the Army, during the War, was well acquainted with the Nature of such Fevers; and having left Directions with him, we did not return till after the Crisis, which happen'd upon the 16th or 17th Day from the Time she was confin'd to her Bed.

306. Some time after this Mr. *Breach* the Apothecary informed us. that he was again employed in *Thomas Wilmot's* Family, for that *Elizabeth Marshall*, his Sister-in-law, after nursing his Wife, was taken ill of the same kind of Fever, and desired our Assistance. This Person we found in the same Bed, and in the same Condition in which we

had seen her Sister some time before; and in the Room with her, in another Bed, a Son of *Wilmot's*, a Boy of nine Years old, ill of the same Distemper. The former had been attack'd on the 15th of *September*, and the latter the Day before. The Woman's Fever ran out the ordinary length of sixteen or seventeen Days, but the Boy's came some Days sooner to a *Crisis*, and was all along of a milder Nature. She recovered very slowly, complaining of great Weakness, Deafness, and a Confusion in her Head, the ordinary Consequences of these malignant Fevers.

307. In my Return I called at *St. Thomas's* Hospital to enquire for one *William Thompson*, a Lad of about sixteen Years of Age, who as *Wilmot* then told me, was another of Mr. *Stibbs's* Journeymen, and had been taken ill by working in *Newgate*, since the three he had mention'd to me before. This Lad was recovered, but not yet dismissed.— He said, that upon finding himself growing ill he had left his Work, and kept at home for about a Week, complaining of a Pain in the hinder Part of his Head, and in his Back, of a Trembling of his Hands, and of restless Nights; that his feverish Indisposition increasing, he had

VENTILATORS. 57

had been obliged to take to his Bed, where he lay about eight Days before he was sent to the Hospital. The Apothecary added, that he had continued about the same Number of Days before the Turn of his Fever; that his Pulse had been extremely low all that time, and that they believed him to be in the utmost Danger. He added, that the Wife of *Michael Sewel* (the second Patient they had received of those that had been employed in *Newgate*) some Days after her Husband's Admission, came to seek Advice for herself, and that her Complaints had been the same with *Wilmot's*, at the Time we saw him; he added, that he had given her some Medicines, but had heard nothing of her since.

308. ON the last Day of *December*, Mr. *Breach* informed me, that about a Month ago, he had been called to attend *Thomas Wilmot*, but as he died before he saw him, he could give no other Account of his Sicknefs, than as they told him, he had long been in a bad State of Health, and that at last he became feverish, and went off with a Loofeness.

309. IN the Beginning of this Month, the Widow apply'd to Dr. *Hales* and me, in order to have the Sufferings of her Family attested and laid before the Lord Mayor, in hopes of having some Provision made for them. Upon which Occasion we learned, that *Thomas Wilmot*, her Husband, after taking the Sudorific, so far recovered as to work at his Business, but that though he did not return to *Newgate*, yet his Strength would not permit him to continue at Work above a Day or two at a Time, still complaining of a Head-ach and Pains across his Breast, or, as he expressed it, about his Heart; of a Feebleness of his Limbs, a Shaking of his Hands, and a constant Drought. That notwithstanding these Ailments, he went out daily till a Week before he died, when he grew very weak and more feverish, had sometimes profuse Sweats, and at other times a Looseness, and that both these Excretions, and also his Breath, were remarkably offensive. That at last he was seized with Convulsions, and having three Fits in one Day, he died in the last of them. His Wife added, that her youngest Son *James*, a Boy of four Years of Age, was after the Father's Decease seized with a spotted Fever, of the same kind with what had prevailed in
the

the Family, but that he recovered; and that her own Mother, *Eleanor Megget*, who did not live in the House, but came often to see them, was also taken ill of a Fever without Spots, and died about ten Days after her Husband. She concluded with telling us, that the Distress of her Family had been increased by their being deprived of all Assistance from their Neighbours, who having thus seen the whole Family, one after another, seized with this Fever, were as much afraid to come near them, as if they had been infected with the Plague.

310. THIS is all the Account I believed necessary to be laid before the *Society*, since a more particular History of it, with regard to its Symptoms, Nature, and Cure, would have been but a Repetition of what I have already published concerning the malignant Fever of the Hospital, from which these Cases are in nothing different.

311. It will be proper to add, that besides these six Persons that were taken ill by working in *Newgate*, and whom I saw, there was another, as Mr. *Stibbs* has lately informed me, but whom I never visited. So that, be-

fides *Wilmot's* whole Family, and *Sewel's* Wife, who received the Contagion at second-hand, there were seven Persons originally seized with the Fever out of eleven only that were employed in the Goal by Mr. *Stibbs*. Now as most of these seven were taken ill within a few Days of one another, and of the same kind of Distemper, it is not to be doubted but that it was owing to the foul Air of *Newgate*.

312. From all which it appears how requisite it is that the Publick should take such Measures as may prevent the like Accidents arising from foul and crowded Goals, or indeed from any Place, wherein a Multitude of People are long closely and nastily kept; and which can never be obtained without a constant Change of Air.

313. Nor are Distempers of this Sort to be accounted among such rare Occurrences as require no particular Provision to be made against them, since from this very Instance it is manifest how often Disasters of this kind may happen without any notice being taken of them. Had it not been for the Accident of our going at that time to *Newgate*, hearing of
of

VENTILATORS. 61

of the first Man's Illness, and seeing his Companion with him, all these Men might have been ill, and not only the Publick, but most of themselves ignorant of the Cause. And as for *Wilmot's* Family, they might have received the Infection, and even have perished by it, without any Person being convinced of the Danger arising from Goals, or the contagious and malignant Nature of the Fever, excepting a few in the Neighbourhood, which is a remote and obscure Quarter of the City.

314. UPON a Representation to Mr. Sheriff *Janssen* concerning the Infection of Prisons, he had the Curiosity to examine Mr. *Elson*, Bricklayer, whose Men were employed in the Repairs of *Bridewell*, in *April* 1750; they found such a Stench in the Work-room and Common-sewers, that they refused to go about the Work without Tobacco and a large Dram; these all escaped unhurt; but the Carpenters not taking the same Precaution, four were infected with the Goal Distemper, and two of them died.

315. WHEN Ventilators are worked by hand in Prisons, it may be well to have a
small

small Wind-mill, with Copper or Brass Sails fixed at the Mouth of the Trunk on the Top of the Prison, which may cause a Hammer to strike a little Bell, which will not only be of use to inform the Goaler, whether the Ventilators are worked as much as they ought to be, but will also be of use to encourage the Prisoners to work them, when they are amused with the Sound of the Bell.

316. IN 1749 Mr. *Yeoman* made a single Ventilator for the Dungeon of *Northampton* Goal; the Midriff six by two Feet. He put Ventilators also into *Shrewsbury* Goal, and in *Maidstone*, *Bedford*, and *Aylesbury* Goals, and *St. George's* Hospital; the four last worked by Wind-mills.

317. THE noxious Air from near the Ceiling of the Wards, which was blown through the Nose of the Ventilators at the Top of *St. George's* Hospital, gave Mr. *Yeoman* and one of his Workmen, a sort of stupid Head-ach, and made him several Times sick to that degree, that they could not continue working in the Place where the Ventilators are, without stopping the Mill: And one of the Governors of the Hospital was sick, by only staying there

VENTILATORS. 63

a short time, to see the sniffling Valves of the Ventilators, which prevent the Air's being drawn too fast out of the Wards, when the Wind-mill turns fast. And the foul Air which ascended through the Trunk on the Top of *Newgate*, made two Workmen who breathed it, vomit instantly to such a degree as to vomit Blood, as they told me.

318. THE Surgeons observe, that since St. *George's* Hospital was ventilated, they are not subject, as before, to spreading Ulcers; these spreading Sores are peculiar to ill-aired Places; so that when they occur in Hospitals, they are often obliged to send such Patients into the Country, where they often get well, by their own Dressing, of such Ulcers as in the Hospitals used to defeat all the Art of the Surgeons. And doubtless, in most other Distempers the Sick will fare the better for having fresh, instead of foul putrid Air.

319. THERE are also Ventilators in *Durham* Goal, and in an Hospital at *Naples*, by means of *Prince Santo Severino*, the *Neapolitan* Ambassador here. They have also Ventilators in *Saxony*, *Silesia*, *Petersburg*, and *Lapland*, for divers Uses.

An

An Account of several Methods used to refresh and cure the noxious Air in the Goals and Hospitals, and private House Hospitals, for the Prisoners and sick Sailors and Soldiers at Portsmouth, Gosport, and Plymouth; by which they find great Benefit; viz.

320. HOLES about six or eight Inches wide, are made in the upper Part of the Windows of the Chambers or Wards of the Sick, by taking out some Panes of Glass, and fixing a Board much broader than the Holes, within-side, opposite to the Holes, at about the Distance of an Inch, more or less, according to the Strength, Coldness or Warmth of the Wind; by which means the entering Air is spread every way sideways, yet so as not to blow directly on, and incommode the Patients. There are also Holes six or eight Inches diameter, made near the upper Part of the opposite Walls of Chambers and Wards; opposite to which Holes are placed within-side, Boards much broader than the Holes, inclining like a Picture, with their upper Part more distant from the Wall than the lower Part. And whereas the Air entering in at one of the Ends of these sloping Boards,

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may,

VENTILATORS. 65

may, especially in small Rooms, blow on and incommode the Patients, that End is stuffed with brown Paper or Rags. The same also is to be done at the Windows, more or less, according to the different Temperatures of the Air, or Strength of the Winds. The Size of these Inlets of fresh Air to be proportioned to the different Sizes of the Chambers or Wards, in private Houses, Hospitals, or Prisons. There are Ventilators in Port *Cæsar* Goal near *Portsmouth*.

321. FRESH Air may also with Safety be let into Chambers of the Sick, by keeping the Door constantly open, and yet preventing its incommoding the Patients, in the following Manner, *viz.* by hanging on a Rail, about seven Feet high, a Canvas-screen between the Bed and the Door. When a lighted Candle is held where the Bed is, the upright Flame shews that there is no Motion of the Air there. But the Flame is much inclined by the Force of the entering Air, when the Candle is held between the Canvas-screen and the Door. But at the same time it appear'd, by a Candle held at the upper Part of the open Door-case, that the upper lighter foul Air, passed out of the

F Room,

Room, being overpowered or impelled by the heavier cooler Air, which entered at the lower Part of the open Door-case; which must needs greatly refresh and purify the Air in the Room. The Position or Number of these Skreens must be diversified, according to the various Positions of the Door to the Bed or Beds; but they must by no means reach up to the Cieling.

322. AND the Door may be fixed at a more or less Degree of Openness, according to the different Temperature of, or Force with which the Air enters.

323. AND in such Wards or Rooms in Prisons as cannot be affected by Doors or Windows, nor opposite Holes in Walls, in the remote Corners are fixed several large Trunks, six or eight Inches wide, which go up through the Floors and Roofs of the Prisons, through which the warm foul Air flies with great Velocity.

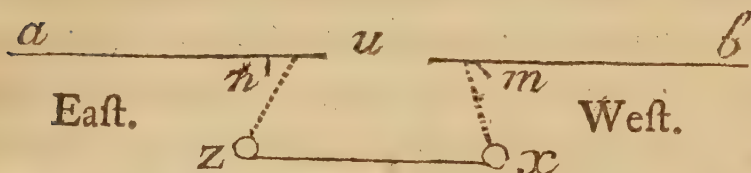
324. AND when the Wind does not blow directly against the Wall which we would have it pass through, a Side-wind may be

con

VENTILATORS. 67

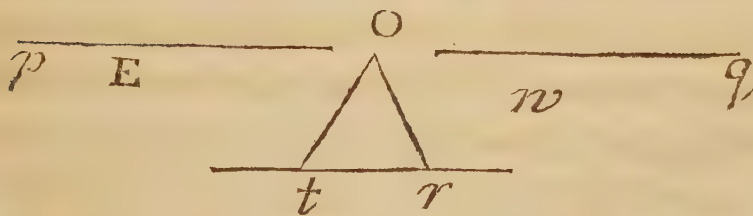
conveyed in, by the following Methods,
viz.

Fig. 14.



Supposing *u* to be a Hole in the Wall *ab*, (Fig. 14.) fix on the outside of it a wide Trunk *xm, zn*, with little folding Doors *zn* and *xm*, moving on Hinges *z* and *x*; by which means, when the Wind is in the East, the Door *zn* opening inwards by the Force of the Wind, will at the same time shut the Door *mx*, and be consequently drove through the Hole *u* into the Ward, and *vice versa* when the Wind is in the West.

Fig. 15.

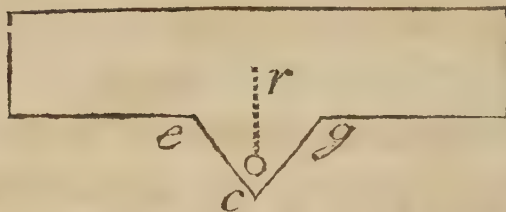


Or the Side-winds may be drove into the Hole in the Wall *o*, by a Triangle of Boards *otr* (Fig. 15.) according to Mr. *Tid's* Contrivance, at his Window Wind-mills. Mr.

68. *The U S E S of*

Yeoman has made a further Improvement on these Methods to turn in Side-winds, *viz.*

Fig. 16.



by having a Door *c r* (*Fig. 16.*) turn on the Hing *c*, so

as to shut against *e*, and thereby close up the opening *e c*, when the Wind is in the West; and when the Wind is in the East to shut against *g*, and close up the Opening *c g*. And when the Wind blows full against the Hole in the Wall *e g*, then the Door will be in Position *c r*, and thereby give a free Admittance for the Wind to blow directly in. By this means much Air might be conveyed in at the Stoke-hole of a Malt or Hop-kiln, through a Door-way, or other large Hole in the Wall, opposite to the Stoke-hole; and when the Wind is at the Back of the Kiln; then shutting the Door opposite to the Stoke-hole, the Air which enters through a large Hole in the Wall at the Back of the Kiln, would be drove forcibly in at the Stoke-hole, and thereby dry the Malt or Hops much the sooner and better, as has been found by Experience. I have been told that Hay-ricks have

VENTILATORS. 69

have been the better secured from heating and firing, by having not only a Well, as usual, in the Middle of the Rick, but also Side-horizontal Holes through to the Well, to blow away the hot Vapour in the Well.

325. IN the upper Garret Wards, at *Hasseler* Hospital near *Portsmouth*, which have no opposite Windows, Mr. *Yeoman* proposed the Opening small Apertures in the Cieling, on the Side opposite to the Windows. And in some Hospitals and Goals, to have Trunks six Inches wide within, to pass through the Cieling, to convey the foul Air off, between the Cieling and the Tiles, and in Prisons, up through the Roof, with a turning Vane-cowl on the Top.

326. THE Commissioners of the sick and wounded Seamen wrote me word, that they found most beneficial good Effects from these several Methods; which were put in practice by the Direction of Mr. *Yeoman*, in the Hospitals at *Portsmouth*, *Gosport*, and *Plymouth*.

327. LARGE Rooms full of Company, and Chambers of the Sick, may be refreshed, especially in warm Weather; and that with-

out being in the least incommoded by the Warmth of the Fire, in the following Manner, *viz.* Having caused a Chimney at the Princess of *Wales's* House at *Kew* to be first swept, a small common Fire-grate was fixed up the Chimney, with its lower Part a Foot above the Mantle-piece. When there was a Fire kindled in the Grate, the Draught of the Air up the Chimney was more than double of what it was when the Fire-grate stood below on the Hearth in the common Way; as was evident, by holding a broad Linen-cloth, from the Mantle over the Face of the whole Chimney, which was by the strong Indraft of the Air blown up to the Fire-grate, as also by the greater Indraft of the Air at the opened Door-case; as was very sensibly to be perceived by a large Linen-cloth suspended over the open Door-case; as also by the much greater Velocity in the Twirlings of a small Brass Wind-mill, fixed at a round Hole about six Inches diameter, in the upper Part of a Window. Some very reasonably propose the refreshing the Chambers, or Wards of the Sick, by causing Air to pass through Cloths dipped in Vinegar, or by hanging such Cloths in Chambers of the Sick.

VENTILATORS. 71

328. BEING informed by an experienced Officer, that the Air in Soldiers Tents is very foul and offensive, especially in wet Weather, the following easy and safe Means to carry off much of that foul Air, occurred to my Thoughts, *viz.*

329. To cut several Holes, about three Inches diameter, on both Sides, near the Ridge of a Tent, and sew to the Ridge, its whole Length, a Piece of Canvas, about two Feet broad, which will lap over a Foot on each Side, and cover the above-mention'd Holes. On the Weather-side, the Canvas-lap, or *Weather-valence*, is to be closed down; but on the opposite Lee-side, it must be raised two, three, or four Inches, more or less, according to the Weather, by means of a long slender Stick or Lath, fixed to its lower Border or Edge, and with a few small Sticks a Foot long, sewed to the Valence, and reaching from the Ridge of the Tent to the long Lath, or by some other proper Means; which Outlets will doubtless greatly refresh the Air in the Tent, and that without being incommoded with Wind, Dew, or Rain.

330. OTHERS as well as myself, have found by repeated Trials, that a Gallon of Air, by being breathed to and fro for a Minute, becomes then so very foul, as to be ready to suffocate. Hence we may estimate, that, by the same means, in an Hour sixty Gallons of Air will be in the same Condition; and if five Men are in a Tent, 300 Gallons of Air will be in the same Condition; and in eight Hours the foul Vapours of 2400 Gallons, or 45 Tuns, that is, six times more Air than the Quantity that a Tent contains, will be thus fouled by the Breath only; besides the much greater Quantity of rancid Exhalations, which perspire from the Surface of the Bodies of those Men: And this, besides the great Quantity of damp Vapours, which in rainy Seasons wrecks from the wet Canvas of the Tents.

331. SOME Estimate may probably be made of the different Degrees of Purity or Impurity of the Air, in such ventilated and unventilated Tents, in rainy Weather, by burning in a Morning, before the Soldiers turn out, some of the lower half of a Candle of six to the Pound, for half an Hour; which Candle has before been burnt the like time in

VENTILATORS. 73

a good Air, and put out with an Extinguisher, to preserve a good Snuff; the Candle to be weighed to a Grain, both before and after each Trial.

332. WOUNDS will heal better in Tents with a good Air, than when that Air is very foul; for the less foul the Air is which we breathe, so much the more salutary it must needs be, not only to those in Health, but also to the Sick and Maimed; but especially to the latter, who by reason of their Maladies, are much longer confined to their Tents.

333. BUT some are of Opinion, that there is no Occasion for this Precaution in Tents, because the Wind blows through the Canvas, especially when dry, and in some degree when wet, as I have found by holding a lighted Candle on the inner Side of the Canvas, when there was a strong Wind: But when there is little or no Wind, it is to be suspected that Tents will be much the more frowzy. Besides, when much of the damp frowzy Air is continually ascending out at the Holes, the Air in the Tent will be considerably the better to breathe in, and the natural requisite

7 Discharges

74 *The U S E S of*

Discharges of Vapour from the Lungs will be so much the less checked. And doubtless, the less the Degree of Dampness of the Air in the Tent is, so much the wholsomer it will be; for the comparatively small Damp of a new-washed Room, is well known to be very unwholsome.

334. THE like Method may probably be useful in Barracks, with folding Weatherboards, made to shut seasonably, by an easy Contrivance by the Wind, or rather by Cowles turning with the Wind, as on Malt-houses.

335. THERE is proposed, Numb. 70. Vol. 1st, to fume Bale-goods with Safety, which are suspected to be infected with the Plague, by unfolding them in a Ware-house, as full of the acid Fumes of burning Brimstone as Men can live in. And when Men are used to them, they will be able to bear a greater Degree of these Fumes than others can do, as I found by Experience when I attempted to go into Mr. *Ward's* Elaboratory at *Twickenham*, where great Quantities of those acid Spirits were made, by burning Brimstone with heated Pieces of Iron, on earthen

VENTILATORS. 75

earthen Platters, placed near the Mouths of very large Glass Receivers, layed side-ways; but I was obliged to retreat immediately: whereas the Women who are used to it, continue long in the Laboratories without being incommoded. I have been informed by a skilful Physician, that the volatile acid Spirit of Vitriol, distilled a second Time from its Colcothar, has been found salutary in the Chambers of those who are sick of the Small-pox, or other putrid Distempers.

336. I FIND by the printed authentic Account of the Precautions used at *Venice*, which was printed in *English*, 1752, that they have two very large *Lazaretto's*, where they put great Numbers of Persons, and large Quantities of Goods, for forty Days, where the Bale-goods of Wool, Cotton, Silk, &c. are chiefly cured of Infection, by opening and exposing them much to the Air, under Sheds, where they are often handled, and Heaps of them opened and turned over and over again; and the same Method was used at *Marseilles*. But I am persuaded, that if this were done in an Air strongly impregnated with the Fumes of burning Brimstone, they might be cured of infectious Qualities, both much sooner, and

more effectually, and with greater Safety to the Persons. For those acid Fumes are most efficacious in destroying the putrescent Quality of the Infection. This Method of fuming Bale-goods will have another good Effect, in preventing Mohair-yarns from being eaten by Moths, which they are apt to be, on being exposed to the fresh Air in *Lazaretto's*: And would probably be a good Means to preserve any Goods that are subject to be Moth-eaten, to have them at first packed up, in such a degree of acid Fumes of burning Brimstone, as the Packers can bear; or to have those Fumes blown into each Fold, from a Machine proper for that Purpose.

337. THE fuming throughly not only the Cloaths separately, but also the Persons of such with only one before fumed Garment on, would probably be of good Use; a Practice that has been long used in *Turky*, and on the *Mediterranean Coast*; by laying them on their Faces, on the Floor of a Room, lest they should be suffocated by the Fumes of the burning Brimstone, and other aromatic Mixtures which they use, and which, instead of promoting, rather abate the Efficacy of the Fumes of the principal Thing, Brimstone, of which

which there is but a small Proportion. But this is a very uncertain and imperfect Way of doing the Thing; because the Fumes of burning Brimstone ascend principally to the upper Part of the Room, as is well known; and I have found by Experiment. For when those Fumes had ascended for a considerable Time, through a wide Iron Tube, in at a Window, in order to destroy Bugs, I could with great Safety, and without being incommoded, walk in the Room: the deadly Fumes reaching in a visible Cloud, not more than four Feet below the Cieling; though by long continuing the Fumigation, the Room was so full of Fumes, as to kill and dry to Powder the Bugs on the Floor. For which Reason the Lazaretto Fuming-rooms ought not to be very high roofed.

338. BUT Persons might bear much stronger Degrees of Fumigation than is usually given them in Lazaretto's, and that with Safety to their Lives, in the following Manner, *viz.* By cutting the Hair off their Heads, and then washing the Head with Vinegar, and covering their Eyes, Nostrils, and Ears with several Folds of Linen-cloth; one of the Folds to be dipped in melted Wax, which
these

these acid Fumes cannot penetrate ; and then fixing their Mouths to short Fawcets or Pipes, only three or four Inches long ; which Pipes are fixed in Holes through the Window-shutters and Doors, or rather through the boarded Sides of the Rooms, in which the Men are to be fumed. When this Fumigation shall be thought sufficient, then to open the Doors and Windows, giving some time for the Rooms to be cleared of the Fumes before the Men venture to take their Mouths from the Fawcets, which will soon be done when there is some Wind to blow them away. There ought to be a Rail behind the Men, for them to rest on. As Men would stand upright in this Manner of Fumigation, they would be much better exposed to the Influence of the Fumes than when they lay prostrate on their Bellies. The Breathing-pipes must not be long, because there would be danger of Suffocation, by their own foul Breath : For, if they were so long as to contain a Quantity of Air nearly equal to the Quantity of Air which they breathe to and fro, they could then breathe no fresh Air. The Truth of this I found by Experiment, near fifty Years since, by cutting asunder the Wind-pipe of a live Dog, through which Orifice he breathed freely.

VENTILATORS. 79

freely. But when I fixed a Gun-barrel to his Wind-pipe, he was soon very uneasy, and in danger of being suffocated, by breathing to and fro the same foul Air; but was presently relieved, on taking away the Gun-barrel.

339. DR. *Langrish*, of *Winchester*, gave a very strong degree of Fumigation to a Dog, by thus opening his Wind-pipe, and stopping the Part next to his Mouth with a Cork; then putting the Dog's Head through a Hole, into a Box, when it was greatly fum'd with the Fumes of burning Brimstone, without killing the Dog, though it hurt his Eyes.

340. It seems probable that Ships may be soon, and effectually cured of a pestilential Infection, in the following Manner; *viz.* By cutting a square or round Hole, about six or eight Inches diameter, through the Windward-side of a Ship, below the lower Deck, and fixing therein a wide Iron crooked Tube, of the same Diameter: The lower End of the Tube to stand on a Stove, in which plenty of Brimstone, with Charcoal, or red-hot Iron, is to be burnt; *viz.* about fifty Pounds
Weight,

Weight, that the whole Ship may be filled with its acid Fumes. Which will be the more effectually done, if there are two or three such Iron Tubes and Stoves, or Hearths, for the Brimstone to burn in at the same time. The upper Deck, Gratings, &c. to be cover'd with Tarpaulins. When the Bales are taken out, to burn in the Ship as much Brimstone as the Men can bear.

341. The Mens Cloaths ought also to be fumed, and then washed in salt and afterwards fresh Water. The Men also to be bathed in, and drink some salt Water, and to take anti-pestilential Medicines; such as Mineral Acids, &c. And if they are afterwards fumed in a Room, as above-mentioned, (Numb. 338.) these will be probable Means, in most Cases, much to shorten the Time of performing Quarentine, as well as effectually to cure the pestilential Infection. Mons. *Du Hamel de Monceau*, (to whom I sent this Proposal) informed me, that these Methods of purifying Quarentine Ships, Men and Goods, are now practised in the *Mediterranean* Ports of *France*, where they traffick much with *Turky*.

VENTILATORS. 81

342. IT is the Opinion of experienced Navigators of long Voyages, that the Scurvy is occasioned more by the noxious putrid Air in Ships, in which there are many Persons, than by the salt Flesh. Many Particles of Flesh, though carefully cured with Salt, will, in time, grow putrid. Dr. *Addington* told me, that he put a small Piece of salted Beef into Water, and at the same time, a like Piece of fresh unsalted Beef, into another like Quantity of Water, and found the salted Flesh to stink first; which shews the very near Tendency of it to Putrefaction, though the Salt keeps it from offending the Taste or Smell. So that salted Flesh as well as putrid Air, has a Tendency to occasion the Scurvy, as well as other Distempers. Hence, no wonder that the living long on very salt Flesh; should contribute to the Muriatick Scurvy, which is frequent among Mariners, not only by its putrid Tendency, but also by causing an Acrimony of the Serum, and Erosion of the small Fibres. And in Ships where they are not only crowded with Men, but have also between Decks many live Animals, for fresh Provisions, the Air must needs be so much the more foul, putrid and unwholesome.

343. THE fappy Vapour which arises from Ships built with green Timber, makes those Ships so very unhealthy, that they continue so to the last of their Duration; this, together with the putrescent Vapour which arises from many human Bodies, and from the stinking Bilge-water, must needs be very noxious.

344. AND as those great Evils are, by happy Experience, remedied by the good and salutary Effects of Ventilators, which are now become in general Esteem and Use in Ships; it will therefore be requisite to give an Account of them, and of the several Methods and Places of fixing them in Ships of different Sizes.

345. AS to the Ventilators which are mentioned Numb. 32. to be put on-board the *Captain*, a 70 Gun Ship, in the Year 1742, and also, not long after, on-board the *Blandford*, a 20 Gun *Guinea* Slave-trader. Knowing that they were received with Coolness by some, and with Contempt by others, as is usual in the Case of new Things, I have reason to suspect that they were very little used, and not with the proper Precautions, so

VENTILATORS. 83

as to make the Ventilation the most extensively beneficial to the greatest Part of the Ship; which is best done, by shutting all the Hatches of the lower Deck during the Ventilation, whereby the Air will be more equably drawn from all Parts between Decks, through the Seams of the Cielings: But if the Hatches are open, then the greatest Part of the Hold, as well as of the Spaces between Decks, will receive little Benefit by Ventilation.

346. VENTILATORS were put on-board the *Laura*, Mr. Reid's Felon-ship. And in the Year 1749, in five *Nova-Scotia* Ships, by Order of the Earl of *Halifax*, and the Board of Trade and Plantations; several of which were fixed on the lower Deck, in the Fore-part of the Ship; which is a good Situation for conveying the foul Air out through the Trunk of the Ventilators, without incommoding those on Deck, which might also endanger their Health. In some of those Ships, they were fixed under the lower Deck, on one Side of the Well, the foul Air coming above Deck, under the Gang-way. The Midribs of these Ventilators were seven Feet ten Inches long, and three Feet ten Inches wide.

347. IN the Year 1751, Mr. Yeoman, who now lives in *Little Peter-street, Westminster*, was sent by the Lords of Trade and Plantations, to *Rotterdam*, to fix Ventilators in four Transport-ships for *Nova-Scotia*. They were placed in two of them close under the upper Deck, to save Bed-room. And they drew the Air out of the Hold, and from between Decks, alternately. For the two other Ships, which had more People, instead of double, he was obliged to make two single Ventilators, with Midribs seven Feet long, and three Feet wide. One of them was fixed on one Side of the Fore-mast, and the other on the other Side of it. They were worked by one common Lever upon Deck, which was fixed close to the Masts, so as easily to be removed or unshipped, as they term it.

348. HE left a Model of a double Pair of Ventilators at *Rotterdam*, and instructed a Person there how to make them. But notwithstanding this his Care to put them in a Way to make and fix them in Ships at *Rotterdam*, yet many Ships, with great Numbers of Passengers on-board, having neglected to have Ventilators, many of their Passengers perished by the Ship-sickness; which put
Mr.

VENTILATORS. 85

Mr. Pen, on proposing to the Assembly at *Pensylvania*, the Making of a Law, to lay a great Penalty on every Ship that has not Ventilators on-board, and do not work them frequently.

349. HE also fixed two single Pair in Mr. *Cramond's* Slave-ships; their Midriffs seven Feet by three. And also in a Corn-ship, where they were fixed between the main Beams of the upper Deck, one on the star-board, and the other on the larboard Side, with the Valves towards the Sides of the Ship; they were worked by one common Lever in the Steerage,

355. IN some Transport-ships he fixed two Ventilators, between Decks, in the Fore-part of the Ship, one on each Side of the Bow-sprit. The working Lever was suspended on an Iron Pin fixed in the Fore-mast. And in order to prevent the wet getting down into the Ventilators, through the Hole in the upper Deck, where the Iron Rod passes from the Lever down to the Ventilators, he makes the Iron Rods not to go directly down into the Ventilators, but reach down, and be fixed to the End of Levers placed lengthwise under

the Ventilators, parallel to the Midribs, and reaching beyond the End of the Ventilators : From which Under-lever an Iron Rod reaches up, and is fixed to the Midribs, to work it up and down ; by which means no wet can get into the Ventilators.

351. THE Benefit of Ventilators in Transport-ships, has been found by repeated Experience, to be very great. I was informed that in a *Liverpool* Ship, which had Ventilators, not one of 800 Slaves died, except only a Child, born in the Voyage ; but that in several other Slave-ships, without Ventilators, there died 30, 40, 50, or 60 in a Ship. Doubtless nothing will contribute more to the Preservation of the Health of Men in Ships, Hospitals, and Prisons, than frequently changing the foul Air, which is apt to putrify when long confined, and then soon communicates its infectious deadly Venom to human Bodies. It cannot therefore be inculcated too much, nor repeated too often, that it is the high Degree of Putrefaction (that most subtile Dissolvent in Nature) which a foul Air acquires in long stagnating, which gives it that pestilential Quality, which causes what is called the Goal Distemper. And a very small Quantity,

tity, or even Vapour of this highly attenuated Venom, like the Infection or Inoculation for the Small-pox, soon spreads its deadly Infection. Ought not Men, therefore, from the common natural Principle of Self-preservation, to use their utmost Endeavours to shun this merciless Destroyer?

352. THE following Instances, as they are strong Proofs of the great Benefit and Usefulness of Ventilators in Ships, so they also fully prove, that they can most commodiously be fixed and worked in them, in contradiction to the vulgar, false, and groundless Notion, that they take up too much Room, and are incommodious, and in a manner impracticable to be worked; whereas the Men are eager to work them; and many more Persons can be with Safety to their Health and Lives, in a ventilated, than in an unventilated Ship; which fully obviates the Objection, as to the Room they take up. In new and important Researches, the likeliest Way to succeed is, to pursue a Thought, not only by imperfect and fallacious Reasonings, but when the Nature of the Thing requires it, with a proper Series of Trials and Experiments. Thus, in the present Case, the principal Cause of the

Sickness in Ships is the noxious putrid Air; the obvious Remedy is, the exchanging that foul Air for fresh, by effectual Means, which are seldom discovered by dwelling only on Objections; but are usually the Reward of repeated, diligent, experimental Researches. Neither are we to be discouraged in these our Pursuits by some Disappointments, for I have frequently found that they lead to the Thing sought for.

353. AND by the like Clue of Reasoning and Experimenting, there is the greatest Probability that we shall succeed in another very important Research, *viz.* the preserving much longer from Decay the Timbers of Ships laid up in ordinary in Harbour: For as we are assured by daily Experience, that the Decay is wholly owing to damp, close, confined, putrid, corroding Vapour and Air; so the only Remedy for this Evil, is the frequently changing the Air and Vapour among the Timbers, by plentiful Ventilations; which we find, by happy Experience, can be effected to such a degree, as gives reasonable Hopes, enough to encourage our further Trials and Researches.

VENTILATORS. 89

354. CAPTAIN *Thomson*, of the *Succeſs* Frigate, in his Letter to me, dated *London*, *Sept.* 29, 1749, ſays, “ That during the Ven-
 “ tilation, the Lower-deck Hatches were
 “ commonly kept cloſe ſhut; by which
 “ means the Air was drawn down into the
 “ Hold, from between Decks, through the
 “ Seams of the Cieling, among the Timbers
 “ of the Ship; by which means we found
 “ the foul Air ſoon drawn off from between
 “ Decks. Our Rule for ventilating was for
 “ half an Hour every four Hours; but when
 “ the ventilating was ſometimes neglected
 “ for eight Hours together, then we could
 “ perceive, eſpecially in hot Weather, a very
 “ conſiderable Difference by that ſhort Neg-
 “ lect of it, for it would then take a longer
 “ Time to draw off the foul Air. Our general
 “ Rule was, to work the Ventilators till we
 “ found the Air from them ſweet. We all
 “ agreed that they were of great Service, the
 “ Men being ſo ſenſible of the Benefit of
 “ them, that they required *no driving* to
 “ work that which they received ſo much
 “ Benefit by. We found this good Effect
 “ from Ventilation, that though there were
 “ near 200 Men on-board, for almoſt a Year,
 “ yet I landed them all well in *Georgia*,
 “ not-

“ notwithstanding they were pressed Men,
“ and delivered me out of Goals, with Di-
“ stempers upon them. This is what I be-
“ lieve but few Transports, or any other
“ Ships, can brag of; nor did I ever meet
“ the like Good-luck before; which, next
“ to *Providence*, I impute to the Benefit re-
“ ceived by Ventilators. It is to be remarked,
“ that we who lay Wind-bound for four
“ Months, with our Expedition-Fleet, which
“ soon after invaded *France*, were healthy
“ all the Time, when they were sickly in all
“ the Ships of that Expedition. This cer-
“ tainly occasioned all kind of Grain-pro-
“ visions to keep better and longer from
“ Weevels, than otherwise they would have
“ done. And other kinds of Provisions re-
“ ceived Benefit from the Coolness and Fresh-
“ ness of the Air in the Ship, from Venti-
“ lation.”

335. MR. *Cramond* also informed me, that he found the good Effect of Ventilators on-board a Slave-ship of his, with 392 Slaves, twelve of which were taken on-board, just before they sailed from *Guinea*, ill of a Flux, which twelve all died; but the rest, with all
the

VENTILATORS. 91

the *Europeans* in the Ship, arrived well at *Buenos Ayres*.

The following is a Letter to me from Captain Ellis, viz.

356. “ Sir, could any thing increafe the
“ Pleasure I have in literary Intercourse with
“ you, it would be, to find that it answered
“ your End in promoting the publick Good.
“ The *Vis Inertiæ* of Mankind, is not the only
“ Difficulty you have had to encounter, but their
“ Ignorance and Prejudices, which are almost
“ insuperable. It is to your Perseverance and
“ Resolution, that the little Progress you have
“ made is due. Indeed, I ought not to say
“ little, for it is a great Step to have found
“ the few that have Hearts good enough to
“ relish your Plan, and Heads sufficiently
“ clear to discern the most effectual Method
“ of advancing it. It does Honour to those
“ noble, and other Personages, that join you
“ in Acts of such extensive Humanity, as the
“ Introduction of Ventilators to Hospitals,
“ Prisons, Ships of War, and Transports, &c.
“ as they must needs render the Miseries of
“ the first more supportable, and the close
“ and constant Confinement of others less
pre-

“ prejudicial and fatal to their Health and
“ Life. It is to be lamented that they are
“ not more generally made use of; for, not-
“ withstanding their Advantage is apparent
“ and incontestable, it is scarce credible how
“ few make use of Ventilators among the
“ vast Numbers of Ships daily employed in
“ carrying Passengers, Slaves, Cattle, and
“ other perishable Commodities. Those of
“ your Invention, which I had, were of sin-
“ gular Service to us; they kept the Inside
“ of the Ship cool, sweet, dry, and healthy:
“ The Number of Slaves I buried was only
“ six, and not one white Man of our Crew,
“ (which was thirty-four) during a Voyage
“ of fifteen Months; an Instance very un-
“ common. The 340 Negroes were very
“ sensible of the Benefits of a constant Ven-
“ tilation, and were always displeased when
“ it was omitted: Even the Exercise had
“ Advantages not to be despised among
“ People so much confined. I must not,
“ however forget, that Ventilation alone is
“ insufficient to keep Disorders out of Ships;
“ for often Infections are brought aboard by
“ the Slaves or others; and frequently Dis-
“ eases are produced by feeding on bad or
“ decayed Food; but oftener still by Inso-
“ briety;

"briety; for I have ever remarked, that the
 "immoderate Use of spirituous Liquors in
 "warm Climates, is more pernicious and
 "fatal, even than the Malignancy of the
 "Air itself. In cold Countries too, where
 "I have had Experience, those Sailors, or
 "others, who accustomed themselves to hard
 "drinking, especially of Drams, had the
 "Scurvy in a terrible degree; whereas those
 "who were temperate and sober, either
 "escaped it entirely, or had it but mode-
 "rately. The Effect of Drunkenness was
 "still more discernible among the *Indians*
 "adjoining to our Settlements in *Hudson's*
 "Bay, who are a feeble, diminutive, chilly,
 "indolent Set of People. On the contrary,
 "those who come from the inland Parts,
 "who are not used to drink Brandy) are
 "brave, active, robust, and industrious. The
 "same Difference is observable in the *Afri-*
 "*cans*, and perhaps among the Inhabitants
 "of most other Nations, did we attend to
 "it. It was to the unusual Sobriety of my
 "Crew that I ascribed, in some measure,
 "their uncommon Healthiness; for Sailors
 "breathe a purer Air, and enjoy more Exer-
 "cise and Liberty, than Passengers or Slaves;
 "wherefore their Ailments are owing to bad
 " or

94 *The USES of*

“ or disorderly living, as well as to unwhol-
“ some Air. Could I but see the immoderate
“ Use of spirituous Liquors less general, and
“ the Benefits of Ventilators more known
“ and experienced, I might then hope to see
“ Mankind better and happier.

I am, &c.

Bristol, Dec.
26, 1753.

HENRY ELLIS.

357. AND by the like good Conduct, in his next Voyage, in the Year 1755, not one of 312 Slaves died; and all his Sailors arrived alive and well at *Bristol*.

358. DR. *Demainbray*, who has shewn Courses of Experimental Philosophy to his Royal Highness the *Prince of Wales*, and *Prince Edward*, in a Letter to me, farther confirms the great Benefit of Ventilators in Ships, viz. “ That in the Year 1753, Ventilators were put into the Vessels in the “ Slave-trade, at *Bordeaux*, and in other “ Ports of *France*; the happy Effect of which “ was, that instead of the Loss of one-fourth “ of those valuable Cargoes, in long Passages “ from *Africa* to the *French* Plantations, the “ Loss seldom exceeded a twentieth. And “ since

“ since my Return to *England*, I have been
 “ informed of a *French* Vessel, which by this
 “ self-evidently reasonable Precaution, saved
 “ 308 out of 312 Slaves, spite of most tedious
 “ Calms, and a long Passage.” And Dr.
Garden, in his Letter to me, dated *Charles-*
Town, South-Carolina, March 24, 1756, says,
 “ It is, indeed, very wonderful, that the
 “ Slave Merchants do not come into the Use
 “ of Ventilators. There are few Ships come
 “ here from *Africa*, (even though they call
 “ for fresh Provisions and Water at the
 “ Islands) but have had many of their Car-
 “ goes thrown over-board; some one-fourth,
 “ some one-third, some lose half; and I have
 “ seen some that have lost two-thirds of their
 “ Slaves. I have often gone to visit those
 “ Vessels on their first Arrival, in order to
 “ make a Report of their State of Health to
 “ the Governor and Council, but I never yet
 “ was on-board one, that did not smell most
 “ offensive and noisome; what from Filth,
 “ putrid Air, putrid Dysenteries, (which is
 “ their common Disorder) it is a wonder
 “ any escape with Life.”

359. AND the Earl of *Halifax* has often
 informed me of the great Benefit they found
 by

by the Use of Ventilators, in several *Nova-Scotia* Transport-ships, twelve to one more having been found to die in unventilated than in ventilated Ships. And there are many more Instances of the salutary, good Effects of Ventilators in Ships. It is, indeed, a self-evident Thing, that the changing the foul Air frequently in Ships, in which there are many Persons, will be a Means of keeping them in better Health, than not doing it; which makes it the more astonishing, that effectual Proposals to remedy so great an Evil, should for so many Years be received with so much Coldness and Indifference by Mankind.

360. BUT, God be thanked, they are now come into general Esteem, from the apparent salutary good Effects of them in our Fleets, Hospitals, &c. In the Beginning of the Year 1756, the Lords Commissioners of the Admiralty ordered them to be put on-board the *Royal George*, our largest Ship: In which the Honourable Admiral *Boscawen*, taking care to have them properly worked, they were found to have the desired good Effect, so to refresh the whole Air in the Ship, as to preserve in good Health 850 People; which
happy

VENTILATORS. 97

happy Event occasioned their being ordered to be put into the whole Fleet. I shall, therefore, here give some Account of the Manner of fixing and properly working them, so as to ventilate all Parts of the Ships; as directed by Mr. *Yeoman*, who was appointed the Contriver and Director of that important Affair.

361. THE following is his Account of his Manner of fixing Ventilators in the Men of War; *viz.*

362. THE Ventilators in large Ships, since the Order for ventilating the Fleet, are fixed in the Gunner's Fore-stoor-room, and generally a-head of the Sail-room. The foul Air is carried up through the Decks and Fore-castle, near the Fore-mast, sometimes afore it, sometimes abaft it, but more frequently on its Starboard-side; the Lever by which the Ventilators are worked, is under the Fore-castle in two-deck Ships, and between the upper and middle Decks in Three-deckers: Sometimes the Lever is hung a-thwart Ships; in some Ships afore and aft; and in others oblique: No certain Rule can be given because
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of the different Construction of the Fore-part of Ships, and working the Gears. The Iron Rod or Spear which communicates the Motion from the Lever, passes through the Partners of the Fore-mast, and is connected with another Lever, which is suspended at or near the Middle; in some Ships over the Ventilators, in others under them, when it is found necessary to fix them up to the Deck, to save Room: The last mentioned Lever is a good means to convey the Motion to the Ventilators, because it is not necessary that the Lever should be in the same Direction with the Ventilators lengthways. The best Method to save Room is, to place the Ventilators one upon the other, with their circular Ends one over the other; the Weight of the Midridges are nearly counter-ballanced by the Iron Rod or Spear which comes down from the upper Lever; if it be not quite sufficient, then some Lead may be added at the Spear-end of the Lever. It is very requisite to have the Air-Trunk so high above Deck, that the Men on Deck may not be incommoded by the foul Air which blows out of it. For which reason the Trunk comes through the upper Deck, near and behind the Fore-mast. Captain

Darrel

VENTILATORS. 99

Darrel told me, that he had a live Chicken held at the Nose of the Ventilators of the *Royal George*, where it soon sickened and died.

363. IN Frigates from 50 Guns to lesser Ships, no general Rule can be observed in fixing them. Sometimes they are obliged to fix them afore and aft, some a-thwart Ships; at other times obliquely. In some Ships they are fixed up to the Deck, and the Lever worked under the Ventilators: And in some of the smaller Ships it is more difficult to fix them; in some Ships they are put into the Hold, and in others under the upper Deck.

364. THE small single Ventilators (*Fig. 6.*) are used to refresh the Air in the Well and Bread-room. While this is working, the foul Air ought to be drawn out from between Decks, by the great Ventilators.

365. *Sizes of Ventilators, &c. to be put on-board of his Majesty's Ships of War.*

Guns.	Ft. Inches.	Ft. Inches.	Ft. Inches.	Inches.
Three Decks. {	100	10 0 long.	4 6 broad.	2 0 deep.
	90	Ditto	Ditto	Trunk or Pipe 12 square.
	80	Ditto	Ditto	11 $\frac{1}{2}$
	70	Ditto	Ditto	11
	60	Ditto	Ditto	Ditto
		Ditto	Ditto	Ditto
50	9 0	4 3	1 6	10
40	8 6	4 0	Ditto	9 $\frac{1}{2}$
20	8 0	Ditto	Ditto	9

366. *N. B.* In two-deck Ships, which are large and capacious in the Hold and between Decks, carrying a great Number of Men, such as the *Invincible*, *Magnanime*, &c. the Ventilators ought to be as large as those of a 90 Gun Ship.

VENTILATORS. 101

367. ALTHOUGH the Dimensions of the Ventilators for 20 Gun Ships are given above, yet as the Construction of those Ships is so very various, the Sizes must be left to the Discretion of the Officers of the Yard; and if Ships of a larger Size, which are already fitted, should be cramped for Room, some small Variation from the above Dimensions may be admitted in particular Instances, provided such Variations be not brought into too general a Custom.

368. IF the Disposition of the Beams and Carlings be such, that the Trunks or Pipes of Conveyance, cannot be exactly an equal Square, they may be made oblong, or of unequal Sides, provided that the Aperture be of the same Area. For Instance, if the Trunk should be 12 Inches square, its Area will be 144 square Inches: But its Size may be varied to 18 by 8, which, multiplied together, make 144, the Area required; and so of the rest. It will not be adviseable to contract them the narrow Way to less than six Inches.

Rules for ventilating large Ships.

369. A PARTICULAR and constant Regard should be had that the Stroke of the Lever, by which the Ventilators are worked, be not made with sudden Jerks, but long and steady, not too quick.

370. WHEN the Hold is to be ventilated from one End to the other, the three Doors of the Gang-way into the Gunner's Store-room, must be opened, and all the Gratings on the Gun-deck to be laid with Tarpaulins over them, leaving all Doors open whose Rooms want Ventilation, on the Orlop, and the Steward-room Hatch. But when it is thought proper to ventilate between Decks, then the Doors of the Gang-way into the Gunner's Store-room, must be shut, and the Scuttle in the headmost Trunk or Pipe, upon the Gun-deck, must be opened, by sliding up the Board which covers it, and all the Gratings of the middle Deck, (if it be a Three-decker; or of the upper Deck, if it be a two-deck Ship) to be laid with Tarpaulins, and, if possible, to open one of the Stern-ports; or, for want of that, the aftermost Hatch-way, or a Scuttle on purpose, through the Deck,

VENTILATORS. 103

as near the Stern as may be. The Times of working the Ventilator will best be directed by the commanding Officer on-board, according to the State of the Ship, Weather, &c. perhaps half an Hour every Watch, or more.

371. I SHALL next mention Instances of Sickliness and Mortality in Ships which had Ventilators, as a Precaution to avoid, as much as possible, the Occasions of it; *viz.*

372. DR. *Brownrigg*, of *Whitehaven*, wrote me word, “ That in two Transport-ships of
 “ that Town, freighted with Protestants at
 “ *Rotterdam*, the Goal Distemper broke out
 “ to such a degree, as to occasion the Death
 “ of 100 out of 160, in each Ship; which
 “ was occasioned by their neglecting to work
 “ the Ventilators for six Weeks, while they
 “ lay there with 50 or 60 Passengers on-
 “ board; during which time the Infection
 “ bred among them; for soon after the Ships
 “ failed, an infectious Fever broke out among
 “ the Passengers, and notwithstanding great
 “ Care was taken to ventilate the Ship every
 “ Day, and though they found such Venti-
 “ lation very refreshing, as well to the Sound

“ as to the Sick (the Air which they pumped
“ out being horribly foetid) yet many died
“ daily, equally among the Sailors as among
“ the Passengers: So that when they arrived
“ in *Nova-Scotia*, there scarce remained Men
“ sufficient to navigate the Ships; and those
“ that did remain were, with great Diffi-
“ culty, allowed to go on shore, for fear of
“ spreading the Infection.” So that, as the
Doctor justly observes, “ Ventilators in Ships
“ are to be used rather as a Preservative
“ against the Production of Goal Fevers,
“ than as a Means of removing the Contagion
“ of such Diseases; or of curing them, after
“ they are produced in such confined Places.
“ The Persons labouring under these malig-
“ nant Disorders, continually emit large
“ Quantities of putrid infectious Exhalations,
“ which can scarce fail of infecting those
“ who are lodged in the same close Places
“ with the Diseased, even though continual
“ Ventilation be used: Ventilators may, in-
“ deed, in such Cases abate the Malignity of
“ the Distemper, and may contribute to the
“ Recovery of the Diseased, but cannot in-
“ tirely prevent the Infection from being
“ communicated from the Sick to the Sound
“ confined with them.” It has been ob-
served,

served, that those Sailors who continue much in their Hammocks, are most subject to have and die of the putrid Scurvy, which they therefore attributed to their Laziness, which may in its degree occasion it. But it is greatly to be suspected, that a principal Cause of it is, their too long continuing in, and breathing the noxious, close, confined, putrid Air in the Ship, whose pestilent Infection has destroyed Millions of Mankind.

372. THE Goal Distemper broke out in Mr. Reid's Convict Transport-ship the *Laura*, notwithstanding the Ship was frequently refreshed by Ventilation. The Convicts were put on-board the latter End of *April*, in seeming good Health, and continued so till they anchored in *Stromness Bay*, in the *Orcades*, when between the 11th and 15th of *May*, a great Part of the People fell sick of the Goal Distemper, in the compass of two Days, which Sickness seized not only the Convicts, but also the Ship's Company, so that many of them also died of the same Distemper.

373. It cannot, therefore, from these Instances be concluded, that Ventilation is of no Service in preserving the Health of People
in

in Ships, because it is reasonable to believe, that the Convicts in the *Laura* brought the Goal Distemper with them from *Newgate*, which they often carry to *Virginia* before it breaks out: For there are many Instances of that Distemper being carried a great way from Ships and Goals, by Persons in seeming Health. Thus in the great Embarkation of many Thousands, who attacked and took *Boc-cacheky* in *America*, I was credibly informed, that many died of the Goal Distemper in every Ship which had Sailors out of the great Guard-ship, at the Mouth of the *Thames*, in which were great Numbers of pressed Men.

374. AND Dr. *Pringle*, the Duke's Physician, informed me, that a Regiment of Soldiers, having caught the putrid Goal Distemper from some Persons in Ships, which carried them in the late Rebellion to *Inverness*, about 200 of them died of that Distemper at *Inverness*. The Remainder of them went in seemingly good Health, a-cross *Scotland* to *Fort William*, where, seven Weeks after, the Distemper broke out afresh among them, and killed many of them; whence the Doctor reasonably infers, that the Seeds of the Di-

VENTILATORS. 107

stemper may lie long latent in the Patient. It is, therefore, very probable that the Convicts brought this Distemper with them from *Newgate*; for the Workmen who put the Ventilators at that time into *Newgate*, told me, that the lower Womens Ward was so intolerably offensive, that they were afraid to go into it to do their Work; there being only a small Window at one End for Communication with the outer Air: Whence it is probable that, besides the near Tendency they might thereby have to be seized with the Goal Distemper in their Constitutions, when they came on-board the *Laura*, they might also bring Infection in their Cloaths, which might take some Time before it broke out into Sicknes. It would be well, therefore, in these Cases early to make use of inward Applications, in order, if possible, to prevent the Breeding of the Distemper, from any latent Cause or Disposition in the Patient; for it is reasonable to think, that this Distemper is much easier to be extinguished by proper Regimen, in this latent Embrio State, than to be cured when it comes to its full Height.

375. AND as Acids are well known to check vegetable Ferment, so are they found of use to check or resist Putrefaction, which is animal Ferment. And accordingly, Physicians, among other Things, prescribe Spirit of Sea-salt to those who have the Goal Distemper. Might it not, therefore, be advisable for Convicts and Slaves, when they come on Ship-board, to drink sometimes Water acidulated with a few Drops of Spirit of Salt, and sometimes to take a little of the acid Spirit of Tar, and sometimes a gentle exhilerating Purge of Sea-water; and often to bathe in Sea-water. It may be well also to fume with burning Brimstone between Decks, the People being all above-deck. There will be little Expence or Trouble in these Precautions. Dr. *Addington* and Dr. *Linde*, give good Directions in their Books, for preserving Health in Ships.

376. IN Cases where it is requisite to keep the Ports shut, and there are no Ventilators in a Ship, it is proposed to open, or partly open, (according to the different Strength or Coldness of the Wind) the aftermost Port on the Weather-side, and at the same time to open, in the same Degree, the Port nearest the

VENTILATORS. 109

the Ship's Head, on the Lee-side; and when the Wind and Waves will permit, and is directly at the Stern of the Ship, then to open a Gun-room Port; thereby to cause a Draught of fresh Air between Decks, from Stern to Head; the Degree of which may be known by the Bend of the Flame of a Candle. According to the Force of the Wind and Waves, either the Gun-deck or middle-deck Ports are to be opened. If the Air which enters at the Stern-port should incommode those who are nearest the Port, the Force of the entering Wind may be much abated by a Canvas, properly tacked or looped up, at some little Distance from the Port, so as to be a Screen to divert the direct Force of the entering Wind. This Method is to be used in Ships that have no Ventilators, and probably, sometimes in Ships with Ventilators, thereby to save some of the Labour of working them.

377. IN the Case of Ships at Anchor, where the Wind is full a-head, it is proposed to have one or both the foremost Ports of the Gun-deck opened, more or less, according to the Degree of Force or Coldness of the Wind: And in order the better to direct the Wind or Air to turn into the Ship, to fix a
Piece

Piece of Canvas, by means of Loops or Loop-holes, to small Tenter-hooks, drove into the After-side of the Port-holes, and also across the Under-side of the open Port, from its After-hinge Corner, to the opposite-outer fore Corner : The lower and fore Borders of the Canvas to be looped to Sticks tied together at the lower fore Corner ; whence another Stick, tied fast at that Corner, is to reach with its other End to the lower Part of the open Port-hole, to be fastened there. It is probable, that the extended Canvas being thus fixed obliquely, at an Angle of 45 Degrees, will give the Wind a Turn into the Ship, so as to cause it to pass between Decks, to the open Gun-room Ports, which, if it does in any Degree, will doubtless make the Ship the more healthy, by clearing off its foul Air.

378. AND whereas, when in Storms the Sailors and the Inside of Ships, are very wet, by the Openings of the Seams of the Decks, that wet State will be more unwholsome in a close unventilated, than in a ventilated Ship ; in like manner as a close-shut wet Room in a House, is much more unwholsome than with Doors and Windows open. Thus also, it is not unhealthy to walk on the damp Earth in

VENTILATORS. III

a free, open, though damp Air; whereas it is well known, that a like or less Degree of Dampness of the Floor and Air, in a closed Room, is very unwholesome. It is, therefore, a Matter of the greatest Importance to be very careful frequently to change the Air in a damp Ship; the noxious Quality of which damp Air is much increased by the great Degree of its Putrefaction, caused by the Heat in the Ship, and the large Quantity of putridly-disposed Vapour, which arises from a great Number of Persons; *viz.* no less than 1200 Pounds Weight from 500 Men, in 24 Hours, at the Rate of 39 Ounces from a Man, as Dr. *Keil* found it, especially when this Damp and Vapour is confined by closed Ports, by reason of Wind and the great Agitation of the Waves, for a considerable Time after the Storm.

*378. A PROBABLE Means lately occurred to my Thoughts, though not perfectly to cure, yet much to abate the Degrees of stinking of the Bilge-water, in the Well of a Ship; *viz.* by laying at the Bottom of the Bilge-water, round the Main-mast, Copper Pipes full of very small Holes, not one twentieth of an Inch in diameter, and blowing Showers of
Air

Air up through them, from small Bellows, fixed out of the Way, within the Well: Such Bellows may be worked with great Ease, for one, two, or three distant Quarters of an Hour, in every 24 Hours, more or less, as shall be found requisite by Experience: But with this Precaution, that whenever the Water stinks much, first to pump it out of the Ship, and after letting in sweet Water, then to ventilate it a little now and then, as shall be found needful; but care must be taken not to ventilate very stinking Water, because it may increase the Unwholsomeness of the foul Air in Ships. By this means Ships will probably be made something the less unhealthy; for the putrid Vapours which arise from stinking Water, must needs greatly contribute to increase the Putridness, and consequently the Noxiousness of the foul Air in Ships, especially in unventilated Ships. This Precaution, with Ventilators frequently to convey off the close foul Air, will be a good Means to make Ships much more healthy.

379. As to the Method of drawing off Air by means of Fire-pipes, it is no new Invention, but was published by Sir *Robert Moray*, in the *Philosophical Transactions*, in the Year

VENTILATORS. 113

Year 1665: And was many Years since applied unsuccessfully for drawing Air out of the House of Commons.

380. AND as it has been since applied, in preference to Ventilators, to the drawing Air out of Ships, not only for preserving the Health of the People at Sea, but also the Ships from decaying when laid up in ordinary; it is therefore incumbent on me to shew the comparative Quantities of Air drawn off by the Fire-pipes, and by Ventilators.

381. THE Fire-pipes are metalline Pipes, about two Inches and half in diameter, one of which reaches from the Fire-place to the Well of the Ship; the other three Branches go to other Parts of the Ship. The Stoke-hole and Ash-hole being closed up, the Fire is supplied with Air through these Pipes.

382. THE Draught of Air through these Fire-pipes, is sometimes sufficient to blow out a lighted Candle; but it is much oftener so weak, as not to be able to do it; as is found by Trials, purposely made: Particularly in the *Namure*, Admiral *Boscawen*'s Ship, in his Expedition to the *East-Indies*, in the *Invincible*,

cible, then a Guard-ship at *Portsmouth*; and of eight *Nova-Scotia* Transport-ships, in the Year 1749: The In-draught of the Air was so weak, that only one of them extinguished the Flame of a Candle, held at the Mouth of the Pipe in the Well by Order of the Right Honourable the Earl of *Halifax*, who was present at the Trial. This Defect has been artfully concealed, by burning Flax, whose broader Flame covering the Orifice of the Pipes, is more sensibly drawn in, and soon extinguished. There is also another Method of disposing the Fire-pipes in Use, which conveys still much less Air; *viz.* by carrying the Pipes through the Fire, thereby causing a small Draught, by rarifying the Air in the Pipes.

383. Now, in order further to prove the very small Quantity of foul Air that is drawn off by the Fire-pipes, I made the following Experiment; *viz.* I fixed the Nose of common Kitchen Bellows to a wooden Trunk, which was 19 Feet long, and equal to three square Inches in the Clear within-side. Upon working the Bellows, a lighted Candle held at the other End of the Trunk, was blown out,

VENTILATORS. 115

out, and the Air rushed forcibly upon the Hand, and would have done the same, had the Trunk been much longer; since whatsoever Air was blown in by the Bellows, must necessarily rush out at the other End of the Trunk.

384. Now, I had found by a former Trial, made on another Occasion, that those Bellows would convey so much Air at each Stroke, as would amount to 37 Tuns in an Hour, which is but one sixty-third Part of 2340 Tuns; which the Ventilators in five of the *Nova-Scotia* Transport-ships, can convey off in an Hour. And the In-draught of the Fire-pipes of seven of the Ships, was still less than this, for it was not sufficient to extinguish a Candle, though the Trials were made when the Fires under the Boilers were at their greatest Height, and consequently drew most Air: Whereas a considerable Part of the Time that the Fires are under the Boilers, is taken up in raising the Fires, and in their Declension; which being allowed for out of the four Hours, during which I am informed the Fires are continued in the Transports, greatly increases the Dis-

proportion between the Quantities of Air conveyed by the Fire-pipes and Ventilators. By this means the People have not any Refreshment of Air, for a considerable Part of every twenty-four Hours; and no Refreshment at all when they most of all stand in need of it; that is, in Storms, when all the Gratings are cover'd, and there can be no Fires. In this Case, when the Storm continues long, it must needs be very detrimental to the Health of the People.

385. WHEREAS Ventilators may be worked during a Storm, and, if Need required, incessantly, Night and Day: Which if it were done, supposing there were 200 Men in a Transport-ship, then it would come to every Man's Turn, once in forty-eight Hours, to work half an Hour, at a very easy Work. But it has been found by Experience, that the working the Ventilators half an Hour every four Hours, preserved in good Health near 200 Men, for almost a Year, in the *Success* Frigate. In this Case it will come to every Man's Turn but once in sixteen Days to work for half an Hour, and that at a Work which it has been found by Experience, they have done

VENTILATORS. 117

done even with Eagerness and Pleasure, being much of Opinion that it was for their Health. Yet this has been one of the grand Objections to the Use of Ventilators; on which Account they were long spoke of with Scorn and Contempt, to the Loss of many Thousands of Lives, which might have been preserved, if they had been made use of ever since they were first invented, in the Beginning of the Year 1741.

386. ANOTHER Way of estimating the very small Quantity of Air that is drawn off by the Fire-pipes, in comparison of what is done by large double Ventilators, is this; *viz.* Whereas the Fire-pipes can only extinguish a Candle when held close to their Nose, my small Ventilator, (*Fig. 6.*) which is about the Size of a Sailor's Chest, will extinguish a Candle at the Distance of five Feet and eight Inches from the Nose, which is sixteen square Inches wide: Which shews that the Fire-pipes must needs convey much less Air than these small Ventilators; which convey 300 Tuns in an Hour; which, though above eight times more than the Fire-pipes can do, would yet be very insufficient for duly purifying the Air of a Ship; because the Quantity of Air which

those small Ventilators convey, is but $\frac{1}{2}$ Part of what the Ventilators in the *Captain* can convey, and but $\frac{1}{78}$ Part of what the Ventilators in the *Nova-Scotia* Ships can do; and would, therefore, be very insufficient to purify the Air of a Man of War, or Transport-ship; much less can the Fire-pipes do it. And their Insufficiency to preserve Ships healthy, is confirmed by Experience.

387. BESIDES the Advantage of better preserving the Health and Lives of People, and also of the Provisions, such plentiful Ventilation will contribute considerably to the Preservation of the Timbers and Planks of Ships, if during the Ventilation the Hatches of the lower Deck being closed down, the Air be drawn through the Cieling from between Decks, among the Timbers, or Ribs, down into the Hold; and this especially if all the Seams of the Cieling of the Hold be calked, or closed, with Lifts of brown Paper pasted over them, except some of the lower Seams, which are above the Bilge-water: By which means also, all the foul Air in the Hold from the Keelson to the lower Deck, will be drawn off: For the fresh Air will enter the Hold towards its lower Part, and this will greatly con-

VENTILATORS. 119

contribute to the better preserving all kinds of Provisions, Store-sails, and Goods in the Hold, which are often damaged by its hot putrid Air.

388. CAPTAIN *Ellis*, Author of the Account of his Voyage to *Hudson's Bay*, and now Governor of *Georgia*, wrote me the following Account, from on-board the *Halifax* Slave-ship, at *Cape Monte, Africa*; viz. he took a Wax Candle, of eight to the Pound, and drew it through a Mould, to make it of one Thickness, from End to End; and found it wasted 67 Grains, in burning thirty Minutes in the Hold, which had not been ventilated in twenty-four Hours: But after six Hours Ventilation, it wasted $944 \frac{1}{2}$ Grains in the same Time, viz. $\frac{1}{3}$ d more.

389. HE placed in the Hold a well-polished Silver Plate, with a Candle and Lanthorn, all blinded except a round Hole of two Inches diameter: He placed the Plate at six Feet distance from it, and with such an Obliquity, that the Rays of Light should fall on its Surface, at an Angle of 45 Degrees. He then fixed a white Paper Skreen, at the same Distance from the Plate, and under the same

Angle with the Lanthorn, that the reflected Rays might fall upon it. He then observed, that the Reflection from the Plate lasted distinctly but seventeen and half Minutes, with an unventilated Hold, it being turned the Colour of tarnished Lead: Whereas, when the Hold was filled with fresh Air, by four Hours Ventilation, the Plate continued to reflect Light, and retained its Brightness four Hours and 41 Minutes.

389. WHEN Ventilation had been omitted twelve Hours, he hung the Ship's Bell under the lower Deck, took out the Clapper, and suspended it by a Line, which with its own Length, made 44 Inches: The Angle which the Rim of the Bell made, with a Line let fall perpendicular from the Pin on which the Clapper hung, was equal to 34 Degrees. He then held the Clapper at the same Angle, on the other Side of the Line, in order that the Strokes at different Times might be with the same Force: When letting it go, it struck the Bell; in its Return he caught it, and counting the Vibrations, he heard them distinctly but three Times; whereas, when the Hold was well ventilated, it vibrated five Times, but its Vibrations were not so quick in the latter as

VENTILATORS. 121

in the former Case. He took all possible Precautions that these Experiments might be fairly tried, to prevent Deception, but always found them to produce the same Effect. The Cargo-Arms, which were in upright Chests, without Wrappers, retained their Polish.

391. WE see in these curious and accurate Experiments, the great Difference in the Purity and Impurity of the Air, of a ventilated and unventilated Ship, and, consequently, the plain Reason why, when such a foul Air putrifies, it not only impairs the Health, and causes the Death of Multitudes, but also damages all kinds of perishable Goods, Store-fails, Provisions, &c. and even promotes the Decay of the Ship, whose Timbers will doubtless rot faster with a hot putrid, than with a fresh cool Air.

392. THE People on-board were all healthy for a considerable time; *viz.* till the Ventilators were so spoiled by the Rats eating not only the leathern, but the wooden Parts of them, in such a manner, that they were obliged to give over the Use of them long before they had any Sickness, when many of their Slaves died of extremely infectious Distempers;

pers; as Small-pox, Measles, Fluxes, and Fevers, which came upon them almost all at once. The spoiling of Ventilators by Rats, might be prevented by anointing them either with Aloes dissolved in Lamp Spirits, or by Verdigrease mixed with Pitch and brown *Spanish*.

393. In order to find the different Degrees of Warmth of the Sea at different Depths, I provided and sent by Captain *Ellis* the following Sea-gage, which was a Pail, or Bucket, to bring up Water from great Depths of the Sea; it was $10 \frac{3}{4}$ th Inches deep, $11 \frac{1}{2}$ wide above, and $8 \frac{1}{2}$ wide at the Bottom. There were round Holes both through the top and bottom Heads, each four Inches diameter, which were cover'd with square Valves, which opened upwards on Brass Hinges; they were cover'd with Leather on their lower Part: They both opened and shut at the same time, by means of an Iron Rod, which was fixed to the upper Part of the lowest, and the under Part of the uppermost Valve: So that as the Bucket is let down into the Sea by means of a sinking Weight, the Water opens both the Valves, and passes freely through the Bucket, which, when it is

VENTILATORS. 123

as low as it is to go, being, after some delay, pulled up again, the Valves will shut, and bring up the Water from great Depths; with *Farenheit's* Mercurial Thermometer fixed in it, to a moveable Stick, which may easily be taken out, it being fixed by Iron Pins both at the Top and Bottom: Then drawing out the upper Pin, the Stick may be easily taken out with the Thermometer fixed to it: But the Ball of the Thermometer must not be taken out of the Water till the Degree is observed at which the Meridian stands. And, in order to this, it will be requisite to put a Cork into the Hole at the Bottom, when the Bucket is drawn up to the Ship, to prevent the running out of the Water when the Valves are opened; also to preserve the Water, in order to know its degree of Saltness: In order to keep the Bucket in a right Position, there are four Cords fixed to it, which reach about three Feet below it, to which Cords the sinking Weight is to be fixed.

394. HE made several Trials with this Seagage. In Latitude $25^{\circ} 13''$ north, Longitude $25^{\circ} 12''$ west, he charged it, and let it down to different Depths, from 360 Feet to 5346 Feet, when he discover'd by the Thermometer,

meter, that the Cold increased gradually in proportion to the Depths, till it descended to 3900 Feet; *viz.* near three quarters of a Mile, whence the Mercury in the Thermometer came up at 53 Degrees; and though he afterwards sunk it to 5346 Feet, *i.e.* a Mile and 60 Feet, it came up no lower: The Warmth of the Water upon the Surface, and that of the Air, was at that time 84 Degrees. He with good reason thinks, that the Water was a Degree or two colder when it entered the Bucket, because in coming up it must probably have been warmed in some degree, for he found, that the Water which came up in the Bucket, after having stood 43 Minutes in the Air, (the time of winding it up) the Mercury rose above five Degrees. When the Water in the Bucket was, by standing a due time, of equal Warmth with the Water on the Surface of the Sea, he tried, by weighing equal Quantities very exactly, as also by the Hydrometer, their Weights, and found, that from below the heaviest, and, consequently, the saltest. With this cool Water they supplied their Bath, and cooled their Wine, which was very refreshing to them.

VENTILATORS. 125

395. I HAVE shewn in my Treatise on Ventilators, Numb. 42, 55, the great Quantities of volatile Vapours which go off from human Bodies, both by Perspiration and by Breath; and also, how apt such Vapours, when long confin'd, are to turn putrid, and thereby produce the pestilential infectious Disease, called the Goat Distemper, or Fever: And it is this putrid bad Quality of the foul Air, and putrid Bilge-water in Ships, where there are many People, which is one of the principal Causes of that common Distemper, the dispiriting Scurvy, of Fluxes, and other Distempers.

396. IN order the more effectually to rouse the Attention of Mankind, in a matter of the greatest Importance to the Health and Lives of thousands, and thereby the more fully and clearly to convince them of it, I have had the following Experiments made, by placing lighted Candles in such foul close confined Airs; it being well known, that the vital Lamp of Animals is either invivified and invigorated, or inextinguished and quenched, in proportion to the different Degrees of Purity or Impurity of the Air which they breathe in.

397. I HAVE found, after variety of Trials with Candles of different Sizes, that the larger Candles, of about six to the Pound, are best for the Purpose; and in order to prepare them for these Experiments, it is proper to cut off, or waste by burning, one-fourth or one-third of the Candles, where they are usually smaller and taper, *viz.* till they are nearly of an equal cylindrical Size: Then first weighing the Candle, when it is well lighted, begin to estimate the time, for its burning half an Hour in a good Air: Then put it out with an Extinguisher, that a fair Snuff, with its black Part about half an Inch long, may be preserved; if it be too long, snuff it to a due Length, in order to fit it for further Trials in foul Airs, it being of great Importance to begin each Trial with a good Snuff: The Candle must be weighed again after each Trial, by burning both in good and foul Air: And in order to preserve a fair Snuff in carrying a Candle into a Mine, &c. it may be well to make a Case for it of Cards, nailed in a semi-circular Form to the Sides of a flat Piece of Wood, about an Inch and a half wide; or to wrap it in stiff Paper with a Stick.

VENTILATORS. 127

398. IF several Candles are prepared at the same time, by burning them first in a good Air, they may be marked Numb. 1, 2, 3, by Holes made near the Bottom with a Pin's Point, and filled with Ink, with the Nib of a Pen; for every Candle which is used in these Experiments must first be tried in a good Air.

399. I DESIRED a Surgeon of the second Regiment of Foot-Guards, to burn a Wax Candle, of about half an Inch diameter, for half an Hour, among the sick Soldiers at the *Savoy*, where it wasted but 11 Grains; whereas the same Candle, in a good Air, had wasted in the same time 27 Grains, which is more than double of what it wasted in that bad foul Air: And he says that the Stench there is sometimes so intolerable, that Candles give but a very weak Light.

400. THE close and low Situation of the *Savoy* Prison, makes it the more requisite to have those Rooms ventilated. Mr. *Adair*, a Surgeon, who was on Ship-board with the large Embarkation of Soldiers, which lay several Months wind-bound in the Channel, and which invaded *France* in 1746, told me, that

that great Numbers of *Harrison's* and *Frampton's* Regiments died of the Goal Distemper, with which they were infected, by about 40 Men enlisted among them, who being Deserters from the *English* in *Flanders*, and taken in the late Rebellion going from *Dunkirk* to *Scotland*, who being confined in the *Savoy*, there got the Goal Distemper. He told me also, that in *Flanders* they dreaded the having of Recruits from the *Savoy*, being apprehensive that they would bring with them the Goal Distemper.

401. DR. *Langrish* made the like Experiment, at my Desire, with a Wax Candle, of six to the Pound, just before the *Lent* Assizes, in the Dungeon of *Winchester* Goal, in the Morning, before Doors or Window-shutters had been opened: The Candle, which had wasted 88 Grains in half an Hour, in a good Air, wasted but $66\frac{1}{2}$ Grains in the Dungeon, in the same time, which is near one-fourth less; and Mr. *Thomas*, a Surgeon of *Chelsea* Hospital, observed the like Disproportion in burning a Tallow Candle, of six to the Pound, in a pocky Room. After the Dungeon had been well ventilated for half an Hour with the Ventilators, the Prisoners remaining

VENTILATORS. 129

maining there all the while, the same Candle wasted in another half Hour, $87 + \frac{1}{2}$ Grains, that is, very nearly as much as in the good Air at first; which shews the great use of Ventilators both in Goals, Hospitals, and Ships. The Doctor observed, that at the first going down into the Dungeon, the foul Air affected the Mouth and Throat with a remarkable Saltness, but not at all at their going down after it had been well ventilated.

402. IN St. George's Hospital, near *Hyde-Park Corner*, a like Tallow Candle, which in a good Air, had wasted in half an Hour, $77 + \frac{1}{2}$ Grains, wasted in the King's Ward, early in the Morning, before Fires were kindled, 70 Grains, *viz.* $\frac{1}{11}$ th Part less: And even this less Degree of Foulness in the Air, by putrifying, is observed to cause putrid Diseases, and to be very hurtful, not only to consumptive Persons, but also to those with broken Limbs, who have their Health impaired thereby, insomuch that they find it requisite of late to leave the Wards sometimes vacant, in their Turns, for a time, to be aired, cleansed, and fumed with the acid Fumes of burning Brimstone.

403. IN Dr. *Stonehouse's* Stable at *Northampton*, with four Horses in it, a Candle, placed near the Cieling, at first opening the Door in the Morning wasted $\frac{1}{6.7}$ less, which shews that this Air was fouler than that in the King's Ward: Dr. *Stonehouse* has, therefore, let fresh Air into the Stable, through Holes made in the Wall, with much broader Boards fixed within-side, at a small Distance, to spread the entering Air thin, so as not to blow directly on the Horses; a laudable Practice, which ought to be imitated in many Stables, where the Horses breathe too hot and foul an Air; whereas a fresher Air would make them more vigorous, and less apt to catch Cold.

404. A PLANT of Spare-mint in a Glass of Water, being, at my Desire, fixed near the lofty Cieling of the *King's* Stable in the *Mews, London*, faded and died soon; a Proof of the Foulness and Unwholsomeness of that close Air, which Grooms and Coachmen are so fond of, and which it is most easy to refresh, to the great Benefit of the Horses.

405. As there are various Degrees of the Unwholsomeness of the Air of Mines, so it
will

VENTILATORS. 131

will doubtless be of great Importance to have a ready Way to know what those several Degrees of Unwholsomeness are in different Mines, and in different States of the same Mine, at different Times, and in different Parts of Mines: And this may be done with sufficient Accuracy, by means of lighted Candles. In order to which, I procured the following Experiments to be made in several Mines, viz.

406. SIR *John Philips*, Bart. of *Pickton* Castle, in *Pembrokeshire*, had a Candle burnt at the further End of the Level, or Drift, of a Coal-mine at *Bigelly*, which was 42 Fathom six Feet and a half from the Pit, and eleven Fathom four Feet deep under the Surface of the Ground; where it wasted but 49 Grains and a half, viz. less than half of what it had wasted in a good Air, which was 101 Grains: So this Air must be unwholsome to a considerable degree.

407. I WAS obliged to the Reverend Mr. *Emmerson*, of *Middleton*, near *Barnard-Castle*, *Durham*, for making the like Experiments with lighted Candles, in Lord *Darlington's* Lead-mines, in his Parish; where he found

they wasted, in burning 15 Minutes, in some Places seven Grains, in others 11, 13, and 15 Grains less than in a fresh Air, more or less, according to the different States of the Air not only in the Mine, but also above-ground, as to its Weight or Lightness, Wind or Calm, which made some Alteration.

408. IN the Drifts, while digging to the Air-shafts, the Air is very noxious; so that a Candle will burn only when held inclining side-ways. But Mr. *Emmerson* having placed a small Ventilator, (*Fig. 6.*) at the Entrance of an Adit, that was digging 50 Fathom to a new Air-shaft, where the Miners complained much of the Badness of the Air when they were got about 20 Fathom, insomuch that they could work but few Hours at a time; yet when the Air was renewed through a long Trunk, which reached from the Ventilators to the Miners, they could then work all the Day with Pleasure. This cheap and easy Method of Relief is, therefore, not only of great Benefit to the Health and Lives of the Miners, but will also be very profitable to the Proprietors and Owners of Mines. On communicating the Success of this Method of ventilating Drifts while digging, to Mr. *Percival*

VENTILATORS. 133

cival at *Bristol*, he put it in Practice in his Mines in *Cornwal*, and that with so good Effect, that it is like to become a general Practice in that Country.

409. AND it is to be hoped that this will lead to the Use of the large double Ventilators, (*Fig. 2.*) layed on each other, as at *Newgate*, in the great and more noxious Mines, where they may be worked either by a Stream of Water in the Mine, or above-ground, or by the Fire-engine that drains the Mine, or by a Wind-mill, which works above three-fourths of the Year, and when becalmed, by Horses.

410. MR. *James Sterling*, who, at my Desire, burnt the like Candles in Lord *Hopetoun's* Lead-mines, at the Lead-hills near *Edinburgh*, found the following Disproportion in Places where the bad Air is; *viz.* at the Depth of 50 Fathom a Candle wasted 71 Grains, which in a good Air had wasted 99 Grains. In another Place, at the Depth of 83 Fathoms, 61 Grains; in a good Air $81 + \frac{2}{7}$; And at 44 Fathoms depth, though the Difference of the Waste of a Candle was but

92 Grains to 85, viz. but seven Grains, only $\frac{1}{3}$ th Part less; yet this Air is esteemed so bad, as to be unfit for working in: But in the Drifts, where there is a free Course for Air, or a good Current of Water, without regard of Depth, there the Difference of the Waste of Candles is very little, and the Air not unhealthy: But where Candles can scarcely burn, Men cannot work, though they may remain there 10 or 15 Minutes, without Inconvenience. The Reason why a Stream of Water makes a Mine healthy is, because the Air riding on the running Water, is carried away with it, and causes a Succession of fresh Air.

411. MR. *Sterling* found those Lead-hills so high, that the mercurial Barometer stands there, at a Medium, one Inch and two-tenths lower than at *Hopetoun* House; which House, as he conjectures, stands about 40 Yards higher than the Sea.

412. IN digging unhealthy Pits or Shafts, the noxious Vapours of them, and the Fumes of Gunpowder in splitting Rocks, may be blown out by the small Ventilators, (*Fig. 6.*)
through

VENTILATORS. 135

through a Trunk about four Inches in the Clear, within : And a tarred Canvas Trunk, about ten Feet long, distended with very small Hoops, may be fixed to the lower End of the wooden Trunk ; which, being flexible, will easily comply with the several Distances of the deepening Bottom of the Pit, where the Men are working.

413. MR. *Percival*, of *Bristol*, informs me, that it has long been the Practice, immediately after each Blast of Gunpowder, to throw down a Fuze Faggot, or to pour down two or three Buckets of Water ; but as the Water thus falling in a large Bulk, cannot wash all Parts of the Air so well as a Shower of Water through the Rose of a watering Pot, I proposed to him the using such artificial Showers, which they find more advantageous for purifying the Air in a Shaft, as it not only washes with its many Streams and Drops all Parts of the Air, but also carries down a greater Quantity of fresh Air, by means of its much larger Surface, when thus minutely divided, than when it falls in a larger Bulk. It may be well for the Man who holds the Watering-pot, to stand on the same Side of the Air-shaft that the Wind is, and to hold

the Pot as high as he conveniently can, that the falling Shower, by avoiding some of the Smoke, may carry down with it the more fresh Air; Water and Air attracting each other.

414. IN Cafes where it is required to have fresh Air descend by one Air-shaft, and ascend by another at a considerable Distance, to increase the Quantity of the descending Air, they cause a Stream of Water to run down that Shaft; but the Quantity of descending Air would be very greatly increased, if that Water was divided into many small Streams like Rain, by falling through innumerable small Holes, made in the Leaden or Copper Bottom of a square Vessel, as large as the Air-shaft, leaving open the Spaces between the Sides of the Vessel and the circular Sides of the Shaft, for a Supply of Air to descend. The same Method will also be beneficial in purifying, with little Water, the noxious Air in the *Well* of Ships. It is observed by Physicians, that a Shower of Rain will make some unhealthy States of the Air healthy. Thus a Shower of Rain greatly checked the Ravage of the last great Plague in *London*.

VENTILATORS. 137

415. *Francis Blake*, Esq; F. R. S. informs me, that they carry on their Drifts of Communication double betwixt Pit and Pit, breaking here and there Holes through the Partition, that thereby the Air may be made to circulate, when by Fire or otherwise its Equilibrium is destroyed; which Methods, though sufficient, in most Cases, to prevent immediate Death to the Workmen, yet he thinks it insufficient to render Mines near so wholesome, as Ventilators of a proper Size would make them. He says further, that it were to be wished that Ventilators could act jointly with the present Methods now in use, both to render them more wholesome, and also to obviate what some object, *viz.* That if, whilst Men are at work in a noxious Mine, the Ventilators, their sole Dependance, should break, what must become of them? But this Objection is of little Weight, unless the noxious Vapours immediately fill the Pit, before the Miners have time to get out, upon the Ventilators ceasing to work. But, allowing this Objection its full Force, he thinks Ventilators would be of use to act in Conjunction with the present Methods that are in Use, as they would conduce to the better Health of the Labourers, whose State, he says, is very deplorable;

plorable ; they earning their Bread in Mines, just not noisome enough to shew an immediate ill Effect, but who, at every Breath, draw in such bad Air, as hastens the Period of their Lives. And here, doubtless, Ventilators would be of great Use, by much increasing the Quantity of fresh Air that would thereby be impelled into the Mine. But the most effectual Method to have the Miners breathe fresh and wholesome Air would be, to have the Air conveyed through a large Trunk, from the Ventilators to the Place where the Miners are at Work ; and by this means the fewer Air-shafts would do, some of which, as I am informed, are sunk at a great Expence. The Trial mention'd Numb. 28, Vol. 1st, was an imperfect Trial.

416. MR. *Erasmus King* very rightly proposes to have Ventilators worked by the Fire-engines, in Mines, which would abate but very little of the Force of the Fire-engine ; because as the Stroke of that is several Feet, and the Stroke of the Midribs of the Ventilators but 12 or 16 Inches, so the Lever of the Ventilators may be proportionably the longer, and consequently be worked with so much the less Force.

VENTILATORS. 139

417. BY the Favour and at the Desire of *John Birkhead, Esq; of Isleworth*, the following Trial was made by *Mr. Lambe, of St. Austel in Cornwall*, with three Mould Candles, of six to the Pound; viz. Nov. 16 they burnt first for half an Hour, in a good Air, and wasted, Numb. 1, 99 Grains, Numb. 2, 100 Grains, Numb. 3, 99 Grains. The same Candles wasted, in burning half an Hour in a Tin Shaft, where they were 27 Fathom below the Surface of the Ground, and seven Fathom below an Adit of good Air, and three Fathom horizontally from the Bottom, 27 Fathom Adit, where they could but just keep a-light; Numb. 1. wasted 61 Grains, Numb. 2, 55, Numb. 3, 51 Grains: At the further End of this Place, which was three Fathom further, a Candle would not burn but when held side-ways slanting.

418. MR. *Lambe* gives the following Description of Damps in the Tinnerns Words, viz. "A damp confined Air is a Thing that
 " deprives a Man of Breath; first, when he
 " comes into it, there is a calm thick Mist;
 " when he sets about working, his Breath
 " decays; the Dust that arises from the
 " Tools, or Pick, and the Smoke of the
 " Candles,

“ Candles, all go into him; so that he
“ breathes for Life with great Difficulty; and
“ what he spits or brings out of his Lungs,
“ is as black as Ink: He will soon have a
“ short tickling Cough, and if he does not
“ take care in time, he will not be able to
“ move out of the Place. In a great Damp
“ the Flame of the Candle is small and white,
“ and can't be perceived to move, and some-
“ times it will quench in an Instant: The
“ more Candles are burnt the worse he
“ breathes: The Damp is most in boggy
“ Ground; not so bad when there is Water
“ in the Shaft; very bad in calm sultry Wea-
“ ther; and when the Wind is brisk it clears
“ great Part of it; A Man that works in
“ these Damps looks very pale, and complains
“ of a great Heaviness on his Breast. These
“ Damps are from seven Fathom to 36 Fa-
“ thom mostly.”

419. THE Tinnors air the Shafts, by means of a long Trunk 2 + $\frac{1}{2}$ Inches wide, wide mouthed, with a Head fixed at the Top, which always turns to the Wind; this might effectually be done, and that in calm Weather, by blowing Air down now and then, through the widened Trunk, with a small Ventilator;
by

VENTILATORS. 141

by this means fewer Air-shafts would do, which Air-shafts, when sunk, give a Current to the Air: Sometimes they tie a Bundle of Furzes to a Rope, and by pulling it up and down, render the Air better for many Hours; which shews, that a small Ventilator, which would refresh more effectually, need not be constantly worked.

420. As the same Method of estimating the Degrees of Foulness of Air in Hot-beds and Green-houses, may probably be of some Use, when further Trials shall have more accurately settled the wholesome and unwholesome Degrees of those Airs; for fresh Air is of great Importance to the Health and Thriving of Plants and Trees, as well as to Animals; for Purity of Air, as well as Warmth, is necessary for their thriving in Hot-beds and Green-houses: I shall, therefore, give an Account of the few Trials which I made.

421. I FOUND the Heat of a Heap of Dung, by *Fahrenheit's* Mercurial Thermometer, to be 104 Degrees above the freezing Point, which is more than half the Heat of boiling Water. *January 14*, a Candle which, in a good Air, wasted in burning half an Hour, 65 Grains,
wasted

wasted 50 Grains, $\frac{1}{2}$ less in a Hot-bed not cover'd with Mold: The Heat of the Dung was 33 Degrees. *Jan.* 18, the Air was so foul as to extinguish the Candle, though the Glass Cover had been on but half an Hour. The Heat of the Air under the Frame was 52 Degrees, but the Heat of the Dung much greater. *Jan.* 21, the Dung cover'd with Mould: The Candle wasted 49 Grains; the Heat 34 Degrees. The Bed is now in a healthy State for Seeds. *Feb.* 1. the Candle wasted 49 Grains; the Heat of the Air in the Frame 54 Degrees; the Cover of the Frame was raised near half an Inch, to let in fresh Air; the Heat 15 Inches; in the Dung 92 Degrees; the Heat of the external Air 17; the Cucumber Plants were in good Health. I made the like Experiments with lighted Candles, in some warm Green-houses at *Hampton-court*, and found a sensible Difference as to the Purity of different Green-houses, but have lost the Minutes of those Trials.

422. THE Air at the upper Part of hot Pine-houses is remarkably offensive; at the same time that the lower Air, and near the Floor, is pleasant and agreeable. The Degrees
of

of Unhealthiness of this upper Air might probably be known, by having some of the same kind of Plant, as Mint, &c. in two Pots, one of the Pots to be placed on the Floor, the other near the Cieling in the bad Air, where Plants have been killed; the noxious Vapours of which, when condensed into Drops, damage the Plants they fall on: Which Inconvenience may, in a good measure, be prevented by refreshing this Air cautiously, with Pannels of Reeds, at the upper Part of each End of the House, in order thereby gradually to convey off the foul and lightest upper Air.

423. THESE and the like Experiments with Candles, will be of great use to shew the Degrees of Unhealthiness of the foul stagnant Air in Goals, Hospitals, Ships, and Mines; but with this Distinction, *viz.* that a lesser degree of Foulness of Air long confined, being thereby become the more putrid, will, on that account, be more noxious than a greater degree of Foulness of Air which has not been long enough confined to become putrid. Thus the long stagnant Air of a common Goal, in which there are comparatively much fewer Persons than in a Ship, will breed the
in-

infectious Goal Distemper; whereas the much fouler Air of a Ship, crowded full of Persons, if it has not been long enough confined to putrify, may not produce that Distemper; though, when long confined, it frequently produces that Distemper, the Scurvy, Flux, and other Diseases, which are the bad Consequences of a putrid Air, which is the principal Cause of the Scurvy. Perhaps frequently repeated Experiments with Candles in the Rooms of those who are sick of different Distempers, may lead to estimate the different Degrees of Putridness of some Distempers, as also shew the different Effects that putrid and unputrid Distempers have on burning Candles: At least it seems very probable, that repeated Trials with Candles, in the Rooms of those who are sick of the most putrid and offensive Distempers, will shew when it is requisite, in some measure, to abate the great Degree of Foulness of such Air, by cautiously admitting fresh Air, and keeping the Bed-curtains close for a short time, till that fresh Air is grown warm, as has been sometimes practised with Success. And whereas a cool fresh Air, though admitted in but small Quantities into a hot Air, will immediately descend, so as to be sensibly felt;
might

VENTILATORS. 145

might it not, therefore, be adviseable to admit the fresh cool Air near the Floor of the Room.

424. I SHALL next give an Account of rational and easy Methods to purify the Air, and regulate its Heat in Melon-frames and hot Green-houses, *viz.* 1. By taking a Pane of Glas out at each End of the upper Side of a Melon-frame, or Hot-house, and then fixing to the Rails of the Frame a Board over the Hole, with a round Hole in it, about four Inches in diameter; the Board to be like a Wedge, so much thicker at the lower End than the upper, as to have its Surface horizontal, on which to fix a wooden or Tin Tube (by sliding under small Ledges or Moldings, the lower spread-out Part of it, so as readily to put on or take off) the Tube to be four Inches in diameter, and a Foot high, with a Cowle on it, made readily to turn to and fro by means of a Vane, so as to have its closed Side always to the Wind, and its open Part from the Wind; for the foul Vapours which arise from the Dung, and Perspiration of the Plants, to pass off incessantly as they rise: And this, without admitting any cold Air, as is done in the common Method, by raising the

L Glas-

Glass-covers a little, which endangers the Plants suffering by Cold. It is probable that more than two of the Tubes will be wanting in long Frames; for the Plants are found to flourish best that are nearest these: Square wooden Tubes with Vanes on them, may probably be better than Tin Tubes, which in cold Weather may condense, and thereby, in some degree, check the Ascent of the Vapours.

425. WHEN, therefore, Plants by this means constantly enjoy a fresh Air, they will probably thrive with more Vigour, and also become more hardy, by being always in a temperate Air, than when they are sometimes stewed in the foul, hot, and close confined Vapour of the Hot-bed and Perspiration of the Plants, fresh pure Air being as requisite and salutary for Plants as for Animals. There is in the middle of the Tin Tube a round Valve, which turns on an Axle, so as to open or close the Tube more or less, when it shall be found needful, in proportion to the different Degrees of Heat of the Dung or Bark, and the different Temperatures of the outward Air: Or there may be a sliding Shutter at the lower End of the Tube.

VENTILATORS. 147

426. IT is very probable, that the Flavour of Melons and Pines will, by this means, be considerably more delicate than when in the common Way they are long stewing in the foul Vapour of Dung or Bark, and of what perspires from the Plants: For, it is a matter of common Observation, that the Fruits on Trees both thrive more kindly, and are also the better flavoured; the more freely they perspire in a pure Air.

427. THERE is another Improvement which, as I have lately found upon Trial, will be of further considerable Benefit in Melon-frames and Hot-houses, *viz.* I laid sloping in a Heap of hot Dung, a leaden Pipe, which was eight Feet long, and an Inch and quarter wide within: The lower End of the Pipe, which was bent a little downwards, was exposed to the open Air, near the Surface of the Ground: The upper End of the Pipe, being bent upwards, came upright out of the Top of the Dung-heap, near the other End of the Heap.

428. THE next Morning, at seven, a mercurial Thermometer being let down eight Inches into the upper Part of the Pipe, the

Heat of the ascending Air raised the Mercury to 111 Degrees above the freezing Point, that is, almost to two-thirds of the Degree of Heat of boiling Water, which is 180 Degrees above the freezing Point. So the external Air being then 16 Degrees above the freezing Point, it was heated 95 Degrees, in two-seconds of Time, in passing the Length of eight Feet up through the Pipe. Whence it may be estimated, by making that Air visible by Smoke, thereby to know its Velocity, that there passes through the Pipe about seven Tuns of Air in an Hour, and in 24 Hours, 168 Tuns; and this incessantly, Day and Night, as long as the Dung retains its Heat: And as its Heat abates, so will the Heat and Quantity of the ascending Air abate.

429. In order, therefore, to have a constant Supply of fresh warm Air, it may be well to have three or four Pipes in each Melon-frame, or several more in Hot-houses, to reach five or six Feet beyond the Back or North-side of the Frame, to be cover'd successively with fresh hot Dung as the former grows cold: And there may be more than one Pipe in each Dung-heap, if required; and if the Bottom of the Dung-heap is a Foot under-ground, to
give

VENTILATORS. 149

give the Pipe a greater Slope, the more Air will ascend up it. Qu. Will it not be well to have each separate Dung-heap inclosed with Boards at the Sides?

430. OR rather, a constant Succession of warm Air may be let into Hot-houses, by having sloping Pipes to pass through the End-walls near the Ground, and also near the Inside of the North-flue hot Wall, four, five, or more Yards long, according to the Length of the Hot-houses, through which Plenty of warm, pure, fresh Air, will incessantly ascend.

431. AFTER *September* we have not Heat enough to correct the Crudities which are imbibed in the long Nights, from the Vapours of the warm Bed, and from the Perspiration of the Plants: But when these foul Vapours are incessantly carried off through these Tubes, the Plants will not be subject to be suffocated with foul Vapours, nor be made too tender by being too much heated, but will be the more hardy; and will, through their whole Progress, thrive more kindly, by having a more free Perspiration, in a pure warm Air; nearly resembling the Summer salutary open Air.

432. AND as Hot-houses will by this means be filled with a constant Succession of warm, wholesome, fresh, unburnt Air, and the natural Floor of a Hot-house or Melon-frame thereby sufficiently warmed, for the Growth of several Kinds of Plants; it seems probable, that they will grow and thrive then in the midst of Winter, covering the Glasses with Mats in very cold Weather.

433. AND by the same means, the Air of too close and smoking Dwelling-rooms, may be refreshed, by having Pipes three or four Yards high in the Corners of the Rooms, with their lower Ends passing through the Walls, the Pipes being in some degree warmed by the Warmth of the Room, the fresh outer Air will constantly ascend warm, so as not to incommode Persons even in Winter. It may be well to have the lower End of the Pipe bent downward on the Outside of the Wall, to prevent strong Winds blowing up it. Qu. Will not such refreshing Pipes be of considerable Benefit in the Chambers of the Sick?

434. IT has in many Instances been observed, that the Air of Chambers over Rooms
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VENTILATORS. 151

where Charcoal is burnt, is very bad; as over the high-pitched Assay-office at *Goldsmith's* Hall, and over large Kitchens where there are several Stoves of burning Charcoal, whose Fumes are not conveyed away through a Chimney, &c. I caused a live Chicken to be held up near the Cieling of a Room where Charcoal was then burning, in the middle of a large Kettle of Water: After some time, the Chicken became so languid and faint, that it could not stand. And, as such subtile and sulphureous Fumes ascend with great Velocity upwards, so I have known an Instance where they penetrated the Cieling and Seams between the Boards so much, as to incommode those who lay in such Chambers, to such a degree, as to oblige them to rise in the Night, and open Windows to admit fresh Air, to prevent being suffocated.

435. AND here it may not be improper to mention an excellent Method which, by often repeated Experience, has been found effectual in curing most smoking Chimnies, *viz.* not to have the Mantle high, and from the Mantle to build the Sides and Breast upright for two or three Yards; the Sides to be no further distant from each other than the Width of

the Fire-grate; and the Breast but 10, 14, or 16 Inches distant from the Sides of the Throat or Back of the Chimney, which will make the lower Surface of the Mantle to be a broad horizontal Plane; a very material Circumstance. The side Jaumbs from the Hearth to the Mantle, to describe a Curve. When Chimneys have a good Draught, it greatly contributes to the having fresh exhilarating Air in a Room.

436. THE airing the Wards of Hospitals, in which there is a constant Succession of sick Persons, does not seem sufficient: But in order to cure the putrid Infection adhering to Cloaths, Walls, &c. it seems requisite to have it sometimes done by the Fumes of burning Brimstone.

437. WHEN we breathe a foul Air, the Lungs being not thereby so much dilated as in a pure Air, the Blood cannot pass so freely through the Lungs to the Heart as it ought to do, and, consequently, the Circulation of the Blood through the whole Body must, in some degree, be retarded; which Circumstance alone must tend much to vitiate the Blood, for the more the Lungs are dilated, so much
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VENTILATORS. 153

the more freely does the Blood pass through them; as was evident in the Case of the fighting Horse, which Action, by dilating his Lungs, made the Blood presently rise the higher in the Glass Tube which was fixed to his crural Artery. *Hæmasicks*, p. 16. And this Reasoning will hold proportionably, in relation to the Foulness of the Air in the Wards or Chambers of the Sick: And, therefore, to let in fresh Air, with due Precautions, has been found of great Benefit to the Sick of some Distempers, particularly in that nauseous Distemper the Small-pox, which fouling the Air much, great Relief has been found by admitting fresh Air.

438. IT is observed of the Lace-makers, that they are of a very sickly Countenance, which Unhealthiness is probably owing to their constantly being in a very stooping Posture over the Lace-cushion; in which prone Position they cannot duly dilate their Lungs, by drawing in a sufficient Quantity of Air, which must needs be very unwholesome; whereas many Women who lead as sedentary Lives in many other Employments, enjoy better Health. And doubtless, in lesser Degrees of stooping forward for a long time, as
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in Tent-work, or other Employments, there will be a proportionable Inconvenience from the thereby lessened Inspirations. The same is also observed in some Parts of *England* where they have got a habit of leaning in a very stooping Posture, with their Elbows on their Knees.

439. ON the *Andes*, the highest Mountains in the World, they can breathe very freely, viz. because the cold Air descends fast to the lower Parts of the Lungs, and there being expanded by Warmth, dilates the Lungs: Whereas on *Teneriff*, where they breathe a warm or hot Air, the Breathing is incommoded. This quick Descent of very cold Air to the lower Part of the Lungs, is thought to cause Pleurifies in the South of *France*, and the like cold Places: To prevent which, many draw their Breath in through a Handkerchief applied to the Mouth. There is sometimes, with an easterly Wind, on the Coast of *Guinea* and of the *Red-Sea*, a dusty Air, which is unwholsome. The like is mentioned *Deuteronomy* xxviii. 24. *The Lord shall make the Rain of thy Land Powder and Dust; from Heaven shall it come down upon thee, until thou be destroyed.* When we breathe

VENTILATORS. 155

a fresh Air, it descends to the lower Part of the Lungs, and thereby drives out the lighter warm foul Air: But when in crowded Rooms, we breathe an Air as hot and damp as that in the Lungs, we then only change in breathing the upper Air in the Lungs, the lower Air being equally hot and light, as the new-breathed upper Air, and, consequently, of equal Weight, the lower Air cannot be changed; but by continuing to grow fouler and fouler, gives that uneasy Sensation which is called a pent Breath. Thus I have found by Experiments, as have several others, that the same Gallon of Air can scarcely, and with great Difficulty, be breathed to and fro for a Minute, by reason of its great Degree of Foulness. It is, therefore, a Matter of great Importance, to use Means to change the Air of such Rooms, by a constant gentle Succession of fresh: But it must not be let in at full open Windows, especially in cold Weather, because it will fall down precipitately, and incommode the Company. There will be another great Convenience in thus changing the Air of crowded Rooms, *viz.* that they will not, when they go out, have the dangerous Inconvenience of a sudden Change,

Change, from a very hot to a very cold, inclement Winter Air.

440. As to the common sick Rooms of private Houses, it is the Advice of the learned Doctor Tschrinhaus, in his *Medicina Corporis*, frequently to change the Air of a sick Room, especially if the Sicknefs have been long; because it is then become putrid: And the good Effect of this Practice is found by Experience in the Small-pox Hospital, as is above-mentioned, Numb. 262. And this is easy to be done in a most gentle and safe Manner, by leaving the Chamber-door open for some time; as is evident, by holding a Candle to the upper Part of an open Door-case, where by the inclining of the Flame, it appears, that the Air goes out of the Room: But if the Candle is held a little lower, the Flame is upright, which shews a stagnant State of the Air: But when held in the lower half of the Door-case, the greater Bend of the Flame shews, that the cooler, heavier, external Air rushes into the Room, and thereby drives out the upper, lighter, more noxious Air, which is thereby happily changed for fresh Air, that principal, genuine, salutary Cordial of Nature; which those who use themselves too

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VENTILATORS. 157

tenderly, are apt to shun, as supposing it unwholesome, because cool ; not considering, that a hot, close, foul Air is, in reality, the unwholesome Air. This Experiment succeeds best at the Door of a Chamber in which the Air is warmed by a Fire, or by Persons being in it for some time. The Endeavours, therefore, to prevent the Admission of any fresh exhilarating Air, by double Doors, lifting Crevices, &c. are doubtless wrong, and is often the Occasion of a dispiriting smoky Air in Rooms. When it is considered how small the Quantity of Air in the Head of a Cradle is, for a Child to breathe to and fro, can it be thought salutary to confine it very close, not only with a Lining, but also with Curtains. Were a Child to breathe that small Quantity of Air as close confin'd as in a Box, it would doubtless be smother'd in a few Hours.

441. MR. *Tidd*, Clerk of her Royal Highness the Princess of *Wales's* Spicery-office, has contrived a Method to admit fresh Air into a Room, in a commodious Way, by taking out the middle upper sash Pane of Glass, and fixing in its Place a Frame-box, with a round Hole in its Middle, about six or seven Inches
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diameter, in which Hole are fixed, behind each other, two or three little twirling Windmills, with Sails of very thin broad Copper-plates, which spread over and cover the whole circular Hole, so as to make the Air which enters the Room, to spread round in thin Sheets side-ways; so as thereby not to incommode Persons by its blowing directly upon them, as it would do, were it not hindered by the Mill-fails, which turn on the same Axle-tree or Spindle, each less than the other. This Method of refreshing Rooms is much approved of, and used by many, not only in *England*, but also in other Countries.

442. THE ingenious Dr. *Pringle*, in his Observations on the Diseases of the Army, says, “ That putrid Diseases are very apt to
 “ be bred in Hospitals, Barracks, Prisons,
 “ and Transport-ships, and in every crowded
 “ Place, where the Air is long pent up, so
 “ as to be corrupted by the perspirable Matter of the Body, which, as it is the most
 “ volatile Part of the Humors, is also the
 “ most putrescent: Hence it is, that in proportion to the Nastiness of such Places,
 “ the Number of Dysenteries and foul Sores,
 “ but above all, of Mortifications, a malignant
 “ nant

“ nant Fever is both frequent and mortal.”
 And he further says, “ It is incredible in
 “ how few Days the Air will be corrupted
 “ in thronged and close Wards : And what
 “ makes it harder to remedy the Evil is, the
 “ Impossibility of convincing either the Nur-
 “ ses or the Sick themselves, of the Necessity
 “ of opening Doors and Windows at any
 “ time for the Air : I have always found
 “ those Wards the most healthy when, by
 “ broken Windows and other Wants of Re-
 “ pair, the Air could not be excluded.—
 “ The Putrefaction of Flesh advances quicker
 “ in a confined than a free Air, because the
 “ most putrid Parts being the most fugitive
 “ and volatile, they incessantly issue from a
 “ corruptible Substance, and disperse with
 “ the Wind : But in a Stagnation of the Air,
 “ they remain about the Body, and by way
 “ of Fermentation, excite it to Corruption.”
 Hence it is, as the Doctor observes, “ That
 “ Goals are the frequent Source of malignant
 “ Fevers in Towns ;” which the ventilating
 of them will effectually prevent. “ Hence
 “ also it is, that the calm stagnant Air of a
 “ Country, with Moisture and Heat, is bad
 “ and unwholsome ; but this Moisture and
 “ Heat, without stagnant Air, is not so putrid
 “ and

“ and bad.” Which shews how salutary Wind is, and at the same time the Reason why in Ships Men are very liable to Distempers from moist and corrupt Air confined. And in his Treatise on Hospital and Goal Fevers he observes, “ That the Degree of Contagion “ and Malignity of these putrid Fevers, depends upon two Circumstances; first, the “ long Continuance of Putrefaction in the “ same Place, and, secondly, the Degree and “ Quantity of it. We have an Instance of “ the first Kind in Goals and Dungeons, “ which are perhaps left foul for Ages; and “ where, by reason of the long Succession of “ animal Filth and Nastiness, the putrid “ Ferment is exalted to so high a Degree, “ that the very Breath and Cloaths of Male- “ factors will spread the Infection. The “ second is most apparent in Hospitals, “ which though of no long standing, yet “ by the great Quantity of putrid Exhalations, will produce the same Effect.” He observes further, “ That a foul Hospital will “ turn any Distemper into a malignant “ Fever.”

443. AND no wonder that a human Body, that is of itself so subject to Putrefaction, should

VENTILATORS. 161

should be apt to fall into a putrefying State, when it is unhappily situated in the midst of a very putrid Air, which is drawn in great Plenty into the Lungs, and thence spreads its Putrefaction into the Blood and Humours of the Body. No wonder then that, as the Doctor observes, “ there is a great Tendency “ to Putrefaction through the whole Course “ of the Disease: A principal Means for the “ Cure of which is, as he observes, to breathe “ fresh Air.”

444. As the most putrid Vapours are the most subtile and volatile, so I observed them to be in the Court at the *Old Baily*, May 11, 1750, when I was obliged to be there; and found the Smell of the Air in the Gallery on the right Side of the Court, sensibly more offensive than below, when I was called down among the Crowd, to give Evidence. And accordingly, those who were situated highest in the Court, as the Lord-Mayor, Judges, *Middlesex* Jury, and those in the Gallery on the left Hand of the Court, were chiefly infected with the fatal Contagion; on which Side a wide Sash-window facing the Judges, was open; at which an easterly Wind entered, which might blow down the most venomous

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Vapour which was near the Cieling, and condense in some degree, and check the subtile infectious Vapour, heated by a crowded Court for many Hours, from ascending so fast from among those on the Bench and in the Left-hand Gallery: Whereas on the Right-hand, where no Window was open, the same Heat might cause the envenom'd Vapour to ascend quicker to the lofty Cieling; as it is well known such Vapours constantly do in Rooms full of crowded Assemblies.

445. As to the preserving the Timbers of Men of War, laid up in ordinary, the longer from decaying, the following Method was made use of, *viz.* all the Seams between the Planks on the Outside of the *Sheerness*, a 20 Gun Ship, at *Deptford*, were caulked, to prevent the escaping of the Air in waste through them: And the lower Seams of the Cieling, or inner Lining in the Hold, were cleared; the lower this is done so much the better, that the fresh Air may enter among the Ribs as low as possible. The Seams of the Cieling of the Fore-part of the Ship were opened about an Inch wide, to give a free Passage to the Air, and thereby prevent its Dampness and Mouldiness, by too stagnant
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VENTILATORS. 163

an Air. The Seams next under the Cells of all the Port-holes, and just over them, were also opened, to give a free Passage for the fresh Air, for want of which they are very apt to decay there. The Ports shut close against several Folds of Lint nailed to the Sides, Bottom and Tops of the Port-holes. All the inner Seams of the Gun-wale, above-deck, caulked, except the uppermost Seam, which is opened all round the Ship, for the Air to pass freely off; and except also the Seam just above and under the Sill of each Port-hole, the Hatches of the lower Deck, and all Holes through it, Gratings, Hawse-holes, Chimney, and all other Outlets for Air, to be well closed. The Lining or Cieling was also closed under the lower Deck, which is usually left open. It seems best to blow the fresh Air into the closed Ship, because there being thereby some degree of crowded Air, it is more likely that it will be compressed into many more Seams and narrow Meanders of the Ship, than if the Air were drawn out of the Ship; because when the Air is drawn out of the Ship, the fresh Air will be drawn in at the Seams of the upper Part of the Ship, and little or no Part of the fresh Air will be brought down among the Timbers of the

lower Part of the Ship: Whereas, when it is directly blown down to the lower Part of the Hold, it must ascend thence through the lowest widened Seams, up among the Timbers to the upper Parts of the Ship.

446. AT the first Trial, only one Sett of such double Ventilators as are used in *Newgate* were put into the *Sheerness*, and worked by a Wind-mill fixed on the Main-deck; but the Fore-part of the Ship being mouldy and damp, for want of opening the Seams of the Cieling of the Fore-part of the Ship, to give a freer Passage for the Air; it was thought adviseable, in order the more effectually to succeed, to have four Setts of such Ventilators, viz. two between Decks, and two in the Hold, all to be worked by the Rod of one Wind mill, which convey into the closed Ship at the Rate of 14,000 Tuns of Air in an Hour, when the Mill turns at the Rate of 15 Times in a Minute; and more or less, in proportion to its greater or less Velocity.

447. *August 11, 1752*, when the four Setts of Ventilators worked at the Rate of 20 Strokes in a Minute, all Hatches, Gratings, &c. being closed, the Blast of Air into the
Ship

VENTILATORS. 165

Ship was so great through the whole Ship, that no single Timber could probably escape the good Effect of it; for the Flame of a lighted Candle, held to the Seams, in almost all Parts, was sensibly blown into them; not only among the more open Timbers, but also in the Channels, where the Dead-eyes are fixed to hold the Masts, in which Places there is a Bed of Timber laid together very close. And this was chiefly done by three new Setts of Ventilators, the old Sett being much damaged by pulling in Pieces, and lying by neglected.

448. A common Quart Bottle being filled about one-fourth full of Water, and having a Glass Tube a Foot long, cemented at its Nose, the Tube went to the Bottom of the Bottle, and was filled half full of Water; the Water in the Tube sunk about half an Inch at every Stroke; by which means we have a true Estimate of the Force with which the Air is impelled into every Seam and Crevice, *viz.* with a Force nearly equal to the Weight of that Part of an Inch Depth of Water. Now, supposing a Gallon of Water to be five Minutes in running through a Hole, the Mathematicians have demonstrated that

24 Gallons of Air would pass through in the same time, with the same Pressure or Force; which shews, that great Quantities of fresh Air must needs pass through all the Seams and Crevices of the Ship: And wherever fresh Air comes, we are assured that Timber will not decay, as it is well known to do in a damp, close, confined, putrid Air: Of which there are innumerable Proofs in Ships, Houses, and every Mortice and Tenon which is subject to wet, where it constantly decays much sooner than in other Parts of the same Timber that are exposed to be wetted by every Dew and Rain, but have withal fresh Air. And that it is the close, putrid Air, and not the wet, which is the great and principal Cause of this Decay, is demonstratively evident from hence, *viz.* those Timbers of Ships that are constantly cover'd with Water, so as no Air can get at them, last long; as do also Elm Piles, and several kinds of Timber, which have probably, some of them, lain wet in Bogs above a thousand Years, and yet sound, because no Air can get at them. And it has been observed by Ship-builders, that the Timbers of Ships which have been caulked on the Inside, have decayed surprizingly sooner than the Timbers of Ships that have not been thus caulked;
And

VENTILATORS. 167

And also the closer the Timbers are to each other, provided they are not so close as to exclude any degree of Air, so much the sooner they are apt to decay. Thus the close confined Air between the outer and inner Lining of a Ship, and between the outer Planks and the Ribs, destroy those Timbers, and corrode the Trunions asunder like *Aqua Fortis*; so that wherever we see Timbers, when laid open, decayed, we may be assured that it is done by that most subtile and powerful Dissolvent, close, confined, putrid Air.

449. WHENCE it may most reasonably be inferred, that wherever fresh Air can be conveyed among the Timbers of a Ship, those Timbers will most undoubtedly be preserved much the longer from decaying. And by thus seasoning the Timbers of a Ship, by drying away the Sap as it perspires, they will become the more tough and hard: The *Sheerness* was made very dry by this Ventilation: And when the Sap is thus dried away, Timber becomes very durable. Thus Beech, which is very subject to decay and to be worm-eaten, becomes very durable, and not subject to be worm-eaten, if when cut out into proper Scantlings for Use, it be laid a

proper time in Water to soak out its Sap, and then be carefully dried under Cover, and not in the Sun. And I am credibly informed, that even Elm Planks, thus well seasoned, will make very durable Barn-floors, less subject to splinter than Oak; a Matter of great Importance now that Oak grows more and more scarce.

450. BUT if the Timbers of Ships did not dry by this Ventilation, yet a close, confined, putrid Air (that most subtile and powerful Dissolvent) will decay those Timbers much sooner than a fresh Air will do, even though they continued damp or wet; for it is not, we see, Wetness alone that decays Timber. Therefore, to find Means to convey plenty of fresh Air among the Timbers of Ships, is most assuredly to find Means to preserve those Timbers much the longer from decaying.

451. OF this we have a strong Proof in the case of Beams and Joyns of Floors over Cellars, which are well known to last above 200 Years without decaying, though never thoroughly dry, where the Air can freely pass through the Windows; whereas the Timber of Cellars and Ground-floors, so closed up that
no

VENTILATORS. 169

no fresh Air can enter, are well known to rot soon. Thus also the Stalls, Pews, &c. in Cathedral Churches last some hundreds of Years, notwithstanding that in damp States of the Air the Stone-walls and Pillars drip with wet, and, consequently, the Stalls, &c. must needs be very damp; yet they are observed to continue long sound, *viz.* because they are surrounded with fresh Air.

452. As to the Intervals of Calm, they are not usually so great as to give time for the Air to putrefy, at most to any considerable Degree; of this we have a Proof in the Timber of the lower Floors that cover Cellars, with open Windows for the Air to pass through, when the Wind blows, notwithstanding the Intervals of Calm. There cannot, therefore, in the Nature of the Thing, be more probable and strong Reasons given for succeeding in this important Affair: We must be content to wait a considerable time for full Proof from Experience.

453. BUT were it necessary or adviseable, in order the more effectually to preserve Ships from decaying, to have a constant, uninterrupted Ventilation of Air, this might be done
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by keeping a Horse or two constantly on-board, to work the Ventilators in calm Weather; the Expence of this would be inconsiderable, in comparison of the great Benefit in preserving such very expensive Fabricks.

454. AND as it is found by Experience in many Ships, that the Hold and Insides of Ships are much cooler and sweeter by Ventilation, so it is reasonable to conclude, that the Ventilating of Ships at Sea by the Labour of Men, will not only be a Means of preserving the Health and Lives of many, and also of the better preserving Provisions; but will be also of considerable Benefit in preserving the Ship itself something the longer from Decay; and this as surely as it is certain that Ships will decay faster with a hot, close, confined, putrid Air, than with a cool, fresh Air. Thus the Timbers of our *East-India* Ships are found to be very subject to Decay, by reason of the hot, foul, putrid Air in the Hold. Hence it is also, that Store-fails, Ropes, and even Cables, are damaged thereby.

455. THE Reverend Dr. *Tucker*, of *Bristol*, informs me, that the Ships which bring Yarn so short a Voyage as from *Ireland* to *Bristol*,
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VENTILATORS. 171

are apt to decay very fast in the Hold, *viz.* by the very hot and putrid Moisture of the Hold; for Heat greatly accelerates and increases the Force of Putrefaction. Thus it has been observed, that if the Guts are taken out of Pigeons or Fowls while they are warm, they will taint and putrefy much sooner than if taken out when cold, *viz.* because Warmth accelerates the Putrefaction of the close, confin'd Air in their hollow Carcasses, which is impregnated with the stagnant Vapours of the Animal: Whereas the Lungs of Animals which have constantly a moist, warm Vapour in them, do not rot, *viz.* because that foul Vapour is continually refreshed with pure Air, so as not to have time to putrefy: And, consequently, when the Hold is kept cool with fresh Air, it will not be apt to rot so fast as when hot.

456. FROM the very putrescent Nature of the Sap of Wood, there is Reason to suspect that this Quality may tend greatly to increase the putrefying Power of the damp putrid Vapour which is confined among the Timbers of Ships; to prevent which, this Method of ventilating Ships seems an effectual Remedy, by carrying off this greatly putrescent, sappy Vapour,

Vapour, which, in Ships built of green Timber, is found to be most destructive of the Health and Lives of Men. And this is fully proved by the following judicious Experiment, which Mr. *Slade*, Surveyor of the Navy, made, *viz.* May 1754, he cut eight Pieces of very green Oak, of an equal Size, and put four of them between the Timbers of the *Sheerness*, a twenty Gun ventilated Ship; and the other four into the like Places, in the *Syren*, a twenty-four Gun Ship, with *Fire-pipes* and open Ports, which Ship lay alongside of the *Sheerness*. The *November* following, two of these Pieces, from the like Parts of those Ships, were taken out, when the Surface of that from the ventilated Ship appeared quite dry, and that from the Ship with *Fire-pipes* was cover'd with a green, hairy Dew or Fungus. The Pieces were replaced again in their former Situation, and taken out the *May* following, when that from the ventilated Ship was remarkably dry, and that from the Ship with *Fire-pipes* did not appear so bad as before, the hoary Mildew being dried to a kind of green and blue Powder; occasioned, as he thought, by the extreme Dri-ness of the Weather. The Piece of Oak in the ventilated Ship weighed two Pounds five Ounces,

VENTILATORS. 173

Ounces, and that in the *Syren* two Pounds eleven Ounces; so that six Ounces more of Sap were evaporated from the ventilated Piece than from the other, *viz.* about $\frac{1}{7}$ th Part of its Weight: A Proof of a very material Thing, *viz.* that the Timbers of a ventilated Ship are in a State of seasoning, and that to a considerable Degree in the Space of a Year. This is therefore what Philosophers call an *Experimentum Crucis*, which proves and shews the Nature of the Thing enquired after, like a Cross in a High-way. And the Timbers of Ships thus seasoned will last much longer, by decaying slower, when at Sea, than the Timber of unseasoned Ships, besides the great Advantage of being more healthy.

457. New Ships are probably subject to decay more, in equal Times, than older Ships, from the more plentiful sappy Evaporation of the new Timber; which being, as it is well known, of a very putrefying Nature, makes such Ships more unhealthy than old Ships are, that are equally or more damp with watry Moisture. If so, then Ventilation is of more Importance to new Ships than old ones, and probably the putrefying Dampness will
sooner

fooner be dried away in new than old Ships, where it has had time to sink deeper into the Timbers.

458. In the *Prince*, a 90 Gun Ship, the four double Setts of Ventilators were placed on the Gun-deck, between the Pumps and the main Capstan; two Setts on the Starboard, and two Setts on the Larboard Side, with their circular Ends within three Inches of each other: By this Position the four Levers are parallel to each other, that is, the Levers of the two headmost are parallel and near each other, as are those of the sternmost. In order to have all these Levers worked by the Rod of the Wind-mill, it was necessary to have a fifth main Lever hung on a central Pin, 12 Inches above the other Levers; which, with the Stroke, was all the Room to spare under the middle Deck. Each End of the great Lever was connected to the other Levers, as in Fig. 17. The lower Part of the Swivels *BB*, take hold of two Levers, and the upper Part of the Ends of the main Lever. By this means all the Ventilators are worked by the Rod *A*, which comes down from the Wind-mill, on the Quarter-deck. Each Sett
of

VENTILATORS. 175

of Ventilators consists of two Ventilators, two being laid first Side by Side, and the other two on them; which, being thus connected, fit one Nose; by which means they may, when Occasion requires, be very commodiously moved from Ship to Ship, without taking in Pieces. Their Midribs are nine Feet long, and four and half Feet wide. The Trunks of these Ventilators pass through the Hatch-ways down into the Hold, into which they convey the fresh Air. The Gun-deck and Deck over it are caulked.

459. THERE are Holes cut in the Middle of the Front of the Side-nostrils, with sliding Shutters, to blow fresh Air, as Occasion shall require, between Decks: At which time the Descent of the Air into the Hold, is prevented with sliding Shutters. And lest these Openings should all at once be inadvertently shut, which would endanger the Spoiling of the Midribs, for want of a free Passage for the Air, therefore this Inconvenience is provided for in the following Manner, *viz.* by cutting a Hole at the Top of each outer Nostril, which Holes are cover'd with an half Inch thick Fir Board, with a leathern Hinge. This Board is to be of such a Weight, as not to

open in common Ventilations, when there is a free Passage for the Air down into the Hold ; but then only to open when those Passages are stopped ; which causes the Air to be impelled with a greater Force : And, therefore, these may properly be called sniffing Valves, *viz.* such as are used to prevent bursting of the Engines which raise Water by Fire.

460. THE Mill-frame is bolted firm with a screw Bolt, which is fixed to an Iron Post, which connects the Quarter and Middle-deck firmly together, which prevents the cutting of a Hole in the Upper-deck, as was done in the *Sheerness*. By this means the Mill may easily and readily be taken down. The Mill-rod, which reaches from the Axle-tree of the Mill down to the Ventilators, is kept steady at each Deck by Sockets of hard Wood.

461. WHEN the Wind-mill is fixed on the Main-deck, as was done to the *Sheerness*, then it must be of such a Height, as not to have its Sails skreened from the Wind by the Quarter-deck or Fore-castle ; in the *Sheerness* the Axle-tree was 17 Feet above the Main-deck. The Mill turns to face the Wind by means of a large Fane of Boards behind. It had eight
Sweeps

VENTILATORS. 177

Sweeps or Arms, twelve and half Feet long. In order the more effectually to strengthen these eight Arms, which are mortised into the central Piece of Wood, the Iron Axle-tree is extended forward about two Feet; from the Extremity of which, Iron Braces went to each Arm, to which they were fastened by Iron Pins, which passed through a strong Iron Circle of six Feet diameter, and through each Arm, where they were screwed fast; by this means the Arms were effectually strengthened.

462. As an Angle of 55 Degrees is found, both by Mathematical Calculation, and also by my own Experience with a small Mill placed before the Nose of my Ventilators, to be the Degree of Weathering, as Mill-wrights call it, or the Angle, or Degree of oblique Position of the Sails to the Wind, for gaining the greatest Force; so an Angle near that, *viz.* of 60 Degrees, has been found by Experience, to do very well in such small Mills: But in common Wind-mills, with very long Arms, the Obliquity of the Sails ought to be less, else their Velocity towards the Extremities, will cause a counter-acting Force at the Back of the Sails. The great Obliquity of

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the Sails of these Ventilator-Mills, has this further great Advantage, that it will move with weaker Winds, which therefore something lengthens the Duration of the Time of the Mill's going: Which Mr. *Yeoman* has observed to be something more than three-fourths of a Year in *Northamptonshire*; and will be more where there are Tides or Rivers, which are found to give Motion to the Air that rides on such moving Waters.

463. IF common Wind-mills were constructed in this Manner, it seems to me probable that the Arms or Sweeps might be something shorter than they usually are, some of which I have known to be 32 Feet long; whereas, could they be made to perform the Work with shorter Arms, it would be much more commodious in several Respects.

464. THE Crown-tree and Sheer-tree have Iron Plates let into their under Sides, which bear upon the two Collars, which are turned true with the Mill-post, and plated with Iron truly ground on its Surface; by which means the Mill turns about very easily, without any Hazard of its getting out of Order: The Mill-rod is kept steady by hard Pieces of

VENTILATORS. 179

Wood let into the Mill-post : The upper Part of the Rod is of Wood, with hard Pieces of Oak fixed in it, where it embraces and takes hold of the Crank ; this Wood is preferable to Brass, not only as it makes less Noise, but also as it is more durable, it having a Bearing six Inches wide : The Brake which stops the Mill is of Iron, which being less tenacious than Wood, will not so suddenly stop the Mill in Storms, and thereby endanger the twisting the Neck off.

465. THE Crank of the Iron Axle-tree of the Mill is seven Inches long, thereby making a Stroke of 14 Inches. The Iron Rod reached down to the great Levers of the Ventilators, to which its Side-brackets were fixed at such a Distance from the Center of Motion of the Levers, as to raise and fall the Midribs twelve Inches : In order to which, the Depth of the Ventilators should be such as to leave full half an Inch above and below, more than the Midribs rise and fall, in order to avoid the great Inconvenience of their striking against the Top or Bottom.

466. CARE must be taken to open the several Seams of the inner Lining or Cieling

of the Ship, in such Places, and in such Proportion, as may best conduce to admit as much as possible a due Proportion of fresh Air to all Parts; which may be guessed at by the Flame of a lighted Candle, held near the Seams in several Parts.

467. AND whereas there may be Trouble, and some Damage, in taking out many Planks of the Cieling, or to examine some particular Places where it may be doubtful whether the Air passes; the following Method occurs to me in doing it, *viz.* to bore Auger-holes, of about an Inch diameter, in the Cieling Planks; through which to put either green, or well soaked oaken Pins, made rounding at each End, that they may readily be pulled out by a String nailed at one End, by which they may be suspended within the Cieling Planks. In order to this, they must not be altogether so long as the Distance between the two Linings. They must be each numbered and weighed, in order to keep a Register of them. The Auger-holes to be corked while the Pins are there. By these and the like Means it is probable, that further and further Improvements will, from time to time be made in the important Affair
of

VENTILATORS. 181

of Ventilation, which well deserves our most diligent Endeavours to bring to Perfection.

468. IT is probable that two Setts of these Ventilators may be sufficient for 20 Gun Ships, three Setts for 40 and 50 Gun Ships, six or eight Setts, with two Wind-mills, for 70, 80, 90, &c. Gun Ships: For a Ship of 1000 Tuns will not want as much more Ventilation as the *Sheerness*, a 20 Gun Ship, which is 500 Tuns: For though the solid Content of one is the double of the other, yet the Surface or Shell, if I may so call it, does not increase in so great, but much less Proportion: For though Spheres are to each other as the Cubes of their Diameters, yet their Surfaces are but as the Squares of their Diameters. And the Business of Ventilation is principally intended to preserve the Shells of Ships. But as Wind-mills are subject to be becalmed near one-fourth of a Year, it will be the more adviseable to have a redundant Quantity of Ventilation when the Wind-mill does work, that it may thereby the more effectually dry all Parts of the Ship; though fresh Air, whether damp or dry, will preserve the Timbers much the longer from decaying. During long Calms the Ports, Gratings, and Hatches

may be opened, especially at first, while the Ships are very damp. Wheresoever fresh Air can be conveyed among the Timbers, there they will not decay in many Years; which brings the Expence of Ventilation, even with eight Setts of Ventilators and two Wind-mills, to nothing in comparison of the Value of the Savings thereby. This important Research ought in Reason to be pursued to the utmost, the frequently changing the Air among the Timbers being the sure and only Means of preserving Ships much the longer from decaying. The *Prince*, a 90 Gun Ship, was compleatly ventilated in all Parts down to the Gun-deck, as appeared by holding a lighted Candle to the Seams: But the Ship received no Benefit below the Gun-deck; the Reason of which was, that the Seams of the Cieling of the Hold were all opened, which ought to have been caulked down to the lowest proper Seam, which ought to be open all round the Hold, about half an Inch wide, for the ventilating Air to enter and pass up among all the Timbers.

469. AND whereas it has been said, that there ought to be no Ventilation in rainy Weather, lest it should make the Ship the damper;

VENTILATORS. 183

damper; in order to prove the contrary, I hung a wet Linnen Cloth under a Shed in my Garden, which was open on all Sides; it had eight Ounces of Moisture in it: Yet in 18 Hours almost continual Rain, seven Parts in eight of that Moisture were dried off. And another time, when the same Cloth was hung there dry, it did not increase one Grain in Weight in 24 Hours Wind and Rain. Hence, even supposing a very damp State of the Air, with a good Wind, when a Ship is first closed up for Ventilation, it seems to me best to ventilate the Ship, notwithstanding, in this Case, it will contribute very little to the drying it, for this Reason, *viz.* that a fresh damp Air being not putrid, will not destroy Timber, as a close, confined, putrid, damp Air will do. This is evident to daily Observation, in the Case of the outside Timber of Houses, which continue sound for more than 200 Years, though wetted by every Dew and Rain during that long Period. But supposing the Timbers of a Ship to be well dried by Ventilation, then it seems reasonable not to ventilate a Ship in very damp States of the Air; for when once dry, probably very little Ventilation will suffice; though even in very dry States of the Air Ventilation will be useful.

And as to the Health of People at Sea, some Degree of Ventilation will be better for them than none; because a hot, close, confined, damp Air, loaded with the Vapours of the Crew, and of putrid Bilge-water, must needs be more unwholsome than a damp fresh Air. I hope, therefore, that these and many other strong Reasons which I have given, will effectually vindicate me in persevering heartily and earnestly to recommend this important Affair to the World. Experience will probably lead to further and further Improvements in the Methods of executing it.

470. It is the just Observation of the ingenious Mr. *Cambridge*, that my Method for preserving Ships from decaying does not, in any degree, disqualify them for being ready to put to Sea, on short Warning, and little Expence: And being on that account the more valuable, the real Merit or Demerit of the Proposal should therefore the more sedulously be inquired into: If I am rightly informed, Ships in ordinary cost at the Rate of ten Pounds a Gun to take out Planks, to prevent Decay, and replacing them again.

VENTILATORS. 185

471. MR. *Reid*, the Owner of the *Salterns* near *Portsmouth*, observes, that his Salt-ships are much preserved from decaying, by the Acid of Salt. And the Timbers of the Hold of *Newfoundland* Ships are observed to be firmer than they naturally are, by means of the Salt of Salt-fish, the Acid of the Salt preserving Timber as well as Flesh, from Putrefaction. And I am informed that the *Dutch* have long practised the laying their Stores of Salt in Ships laid up in Ordinary, in order to preserve them. And it has probably this good Effect, not only where the Salt actually touches the Ship, but also in more distant Parts, by the Influence of the acid Vapour which flies off from Salt; as may be seen in the Brick-walls of Rooms where Salt, or salted Provisions are kept; which Walls are thereby corroded through to their Outside; and this notwithstanding the Salt does not touch those Walls.

472. IT is his ingenious Conjecture, that fresh Air contributes to preserve Timber, not only by keeping it dry, but also by the acid Spirit in such Air: Whereas a long, close, confined Air, being deprived of a constant Supply of that acid Spirit, not only turns
putrid

putrid itself, but also greatly contributes to the putrefying of any adjoining Wood, &c. And this seems to be the probable Reason why, when fresh Air is admitted into an Ice-house, by opening the Doors to take out some Ice, then the Ice melts fast; but when the Doors are closed again, so as to prevent the Entrance of fresh Air, stored with a new Supply of Acid, then the Degree of melting abates, in proportion as the last admitted Air is by the Ice in the Ice-house deprived of its acid Spirit. Thus common Salt mixed with pounded Ice, does, by virtue of its Acid, dissolve the Ice fast, and that even though the Cold is thereby, at the same time, increasing to a very intense Degree for about seven Minutes; after which the intense Cold gradually abates. Mr. Reid therefore proposes the putting Salt among the Timbers of Ships, as a Preservative; and if the Salt be mixed among Oakham, not only the less Salt will suffice, but it will thereby be the better retained in all Parts among the Timbers. And as he observes in his Treatise on the Acid of Tar, that the *Finlanders*, by painting the Timber of their Houses with this Acid, worked up with red Okre pulverized, make them last for 100 or 150 Years or more; and that
dry

VENTILATORS. 187

dry Wood does not decay while it retains its acid Juice; for the driest Wood, if perfectly sound, yields a great deal of it; but there is none in rotten Wood: He proposes it, therefore, to be consider'd, whether this Juice, prepared either with Copperas or Okre, or perhaps Verdigrease, may not preserve Ships from rotting and worm-eating; as the acid Spirit of Vitriol with Copperas does. Hence it may be well to try whether the laying seasoned Trunions, or other Wood, to soak in the acid Liquor of Tar, which is every where thrown away as uselefs, may not contribute to the longer Preservation of Ships.

473. IN order the better to preserve Ships, such as Bomb-vessels and Merchant-ships, that do not continue long enough in Harbour to make it worth the while to have Ventilators, the following cheap and easy Method may be used, *viz.* to have a round Funnel of thin Boards, or old Canvas, or Tarpaulins, fixed at one End of the Ship through the upper and lower Decks, and reaching full half-way the Depth of the Hold; its Diameter to be about a Yard, or as wide as the Hatch-way will admit; with a Coul on the Top of this Funnel, turning with the Wind,
like

like those on Malt-houses, but with its open Part always towards and facing the Wind. And if it shall be found requisite to obviate the Inconvenience of the Rains driving in at the Opening of the Coul, which always faces the Wind, it may easily be remedied, by placing at some Distance below the Bottom of the Funnel, a Piece of a Tarpaulin, in such a sloping Manner, as to receive and convey the Rain that falls on it, into a proper Vessel. It will be very requisite also to have another like Funnel and Coul, to pass through the upper and lower Deck at the other End of the Ship; this Coul to have the open Part always turn from the Wind, as those on Malt-houses do: By this means there will be a very considerable Draught of Air pass through the Ship, whenever the Wind blows from any Quarter; even as much when the Wind blows on the Sides as when on the Stern or Head in the common Way: A material Circumstance, which the holding a lighted Candle when the Wind is side-ways in Ships, with and without Couls, will plainly shew. All the Hatches of the lower Decks must be shut, except the Hatch which is most distant from the Coul whose open Part faces the Wind, for by this means the whole Hold will

VENTILATORS. 189

will be the more refreshed: And it may probably be proper to have a Hole on the Side of the Funnel, through which the Air descends, for some of the fresher Air to pass between Decks, if sometimes all the Gratings are closed. This Method will probably be very serviceable to refresh Mines. In order to shew the Reasonableness of this Proposal, I fixed a Box, a Foot square within, on a Trunk nine Feet long, which was within equal to three square Inches: This Trunk was fixed on the East Side of a Garden Wall, so as to have the Box three Feet above the Wall, with its Mouth sideways facing the West.

474. THE Wind being then more than half a Storm full West; when the Hand was held at the Bottom of the Trunk, the descending Air was very sensibly to be felt; and the Flame of a Candle was blown down to the Tallow, and extinguished if turned round while held sideways there. When a Glass Tube, near half an Inch diameter within, was fixed and closed in the Bottom of the Trunk, and the lower End of that Tube was immersed a little way in Water, then, in the strongest Gusts of the Wind, the Water

in the Tube descended about $\frac{1}{16}$ th Inch, but not at all at other times. So the Force of the compressed Air was but $\frac{1}{16}$ th of the Force of the ventilated Air in the *Sheerness*, where the Water descended an Inch at each Stroke of the Ventilators. Therefore, this Method would be insufficient to drive plenty of Air among the Ribs: But yet, by this means 27 times more fresh Air might be conveyed into a Ship in ordinary, than can be done by the four Fire-pipes, as I found by Calculation, and this without the Expence of Fire.

475. As in distilling stinking Sea-water, I observed the stinking, putrid Parts of the Water to rise first, leaving the remaining Water sweet; so the Volatility of the most putrefying Vapours, shews the Reason why Ships are most subject to decay under the Cells of the Port-holes, where the higher Ascent of these Vapours is stopped; where, by their Stagnation, they remain, and by way of Fermentation rot the Timber, the Sap of which is very subject to Putrefaction; as is evident by the known Effect of the Sap of a green, unseasoned Pump's causing the Water of a Well to stink; which is also the Reason why Ships built of green, sappy Timber, are
always

VENTILATORS. 191

always very unhealthy, its putrefying fappy Vapour, mixed with the putrid Vapour of the Bilge-water in the Hold, and the putrid Perspiration of the Men, greatly promoting the Putrefaction of the close confined Air between Decks; which Inconvenience will effectually be prevented by Ventilation; which I mention Vol. I. Numb. 44.

476. WHERE the Earth under the Ground-floors of Houses is damp, and, close confined, it not only rots in a few Years the Joyce and Boards of the Floors, but also, by its ascending putrid Vapour, the very Wainscot of those Rooms, as it does the upper Works of Ships: Whereas, when the Earth under Ground-floors is dry, they do not rot, notwithstanding the Air is close confined under those Floors: Which both shews the Reason why the Timbers of Ships are so apt to rot, where there is a damp, close, confined Air; and also the great Importance of changing that Air often, by plentiful Ventilation, and thereby drying those damp Places, which will doubtless contribute much to the longer preserving of those Timbers. And whereas a damp, stagnant, close, confined Air, is well known to rot Timber much faster than a damp

damp fresh Air ; this shews the Reasonableness of ventilating Ships in ordinary, even in damp States of the Air. And whereas Men are very liable to Distempers from moist, corrupt Air in Ships, especially in long stormy Weather, when Hatches, Ports, and Gratings are closed ; it is for the same Reason best to ventilate the Ship, even in damp Weather, viz. because a damp fresh Air is not so very unwholsome as a damp, close, confined Air.

477. THE Owners of the Horse-ferry Boats at *Richmond* and *Kew*, complaining to me that the thick Fir Planks of their Floors were subject to decay and rot in a few Years ; and I observing that they were so close that no fresh Air could get in : I proposed to them the free Admittance of fresh Air ; which they did by cutting away those Parts of the Floor on each Side, which were between the upright Timbers or Ribs ; to which they nailed thin Fir Boards about five Inches broad, to prevent the falling of Dirt under the Floor. By this means the fresh Air has a free Admittance under the Floor, as is evident by holding a Piece of Paper, or Handkerchief, over any one of the Air-holes between the Ribs, on one Side of the Boat, when the Wind

VENTILATORS. 193

Wind blows against the Inside of the opposite Side, when the Paper will be blown upwards; and, *vice versa*, downwards, if the Paper, &c. be held in like manner on the opposite Side: a plain Proof that the fresh Air passes freely under the Floor of the Boat; which will doubtless preserve it many Years the longer from decaying: When the Water has been laded out, the fresh Air has dried up the remaining Damp under the Floor.

478. BESIDES the common Motives of Humanity to use our best Endeavours for preserving the Health and Lives of Mankind, there are some peculiar to this unhappy Age; in order to counter-balance, in some measure at least, the astonishing Havock and Destruction that is made of the Lives and Morals of Mankind, over a great Part of the World; occasioned by fermented distilled spirituous Liquors, which even debase the Breed of Man: An Evil so amazingly great, that did not woful Experience too fully prove it, it would seem incredible to believe, that any whom it concerns, could possibly be so negligent, as not to use their utmost Endeavours to suppress that destructive *Man-Bane*.

479. It is the just Observation of Dean *Conybeare*, in his Sermon on the Thanksgiving-day for the Peace, 1749, *viz.* “ Here
“ then the true Lover of his Country has a
“ noble Field of Action; and he is so much
“ the more concerned to attend to this Point,
“ because the Decay of Morals in this present
“ Age is notorious: Vices to which Men
“ heretofore were tempted only by Affluence,
“ are now derived down to the lowest Part
“ of the People; so that those in whose
“ Virtue and Diligence heretofore consisted
“ the main Strength of the whole, are now
“ become more and more a Burthen. The
“ Consequence of this is dreadful, and there-
“ fore the Concern to prevent it must be
“ obvious.”

480. As there is an Abatement of one-third of the *British* Distillery, by reason of the Excise laid on those Spirits, so it is a good Omen that an effectual Restraint will be laid on those most destructive Liquors. How humane and laudable an Example will this be to those other Nations of the World, where this greatest of all Evils that ever befel unhappy Man, makes an uncontrolled, amazing
Havock

VENTILATORS. 195

Havock of the Lives and Morals of Mankind.

481. THAT eminent Physician Dr. *Hoffman*, in his seven Rules for preserving Health, expressly cautions against the Use of distilled spirituous Liquors: "Because, he says, they
" are above all Things most unwholsome ;
" because caustick burning Spirits, by inflaming the Solids, and coagulating and
" thickening the Fluids, cause Obstructions,
" which bring on many fatal Diseases ; such
" as Hectick Fevers, Jaundices, Dropsies,
" &c. whereby Multitudes are daily and
" yearly destroyed. And also that they rot
" the Intrails, such as the Liver, Stomach
" and Bowels ; as is evident, he observes, not
" only by opening the Bodies of those who
" are killed by drinking them, but also by
" what is observed in *Germany*, of the Effects which the caustick, fiery, remaining
" Wash of Distillers has on the Guts of
" Hogs, which are thereby so rotted, that
" they cannot make Hogs Puddings with
" them." And to the same Cause, together
with the greater Quantity of Liquor which
they swallow down, it is doubtless owing, that
the Bladders of such Hogs are much larger
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than those of other Hogs, *viz.* because being tender, they more easily distend in blowing up: And the whole Flesh of such Hogs is so much tenderer, that it will not keep by salting, so well as the Flesh of other Hogs will do.

482. IT is the known Observation of Dealers in Hair for Wigs, that they can distinguish the Dram-drinker's Hair by the Touch, finding it dry, harsh, dead-ended, and unfit for Use. And in the same manner it is, that it spoils the Stomach and Bowels, the Liver and Lungs, and the whole Body of those unhappy Persons.

483. AND it is very observable, that these pernicious distilled Spirits not only hurt the Bodies, but spoil the Tempers even of Hogs; for it is a known Observation, that if a Distiller's Hog cries out with the Voice of Distress, the other Hogs will fall on him and destroy him, if he is not immediately taken from them; whereas it is well known, that the Farmers Hogs are zealous in defending each other, when they cry out in Distress.

484. AND distilled Spirits have the same bad Effect in depraving the Tempers of Mankind, by heightening their Passions, or making them perverse and cross: They tend greatly also to the depraving of their Morals, by quenching the Spirit of Religion to such a Degree, as to make them prophane and abandon'd, as to all Sense of Duty to God and Man; as also wholly regardless, either of their own present temporal, or future eternal Welfare and Happiness. Thus, not only their temporal bodily Health is irreparably depraved to such a degree, as that, by the concurring Testimony of all Physicians, it cannot be restored; for Medicines have no healing Efficacy on such; but what is infinitely worse, and an astonishing Consideration, their Souls are debased and sunk at so vast a Distance from all the healing Influences of Religion, that they have no Sense of, nor Longings after, *the Fountain of ever-living Waters*: For human Nature is so excessively debased by distilled spirituous Liquors, that it would be no inconsiderable Degree of Happiness to be raised thence, even no farther than to the low State and Condition of brute Creatures: For it is an unjust and disparaging Comparison, even to the brute Beasts, to compare an ha-

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bitually drunken Dramist to those sober, temperate Creatures, who have a strong natural Affection for their Young-ones, which is notoriously extinguished in Dramists. God, who has curiously wrought our wonderful Frame out of the Dust, knowing how prone we are to disorder it by Irregularities, of his tender fatherly Care for us, has not only implanted in us a strong Desire of Life and Self-preservation, but has also strictly enjoined us to avoid all destructive Irregularities and Vices, and the Practice of those Virtues which are so well adapted to our Nature, that they have a natural Tendency not only to keep the Body in Order, but also to give *Health to the Soul*, as well as *Marrow to the Bones*, Prov. iii. 8. Yet how is this delicate, this curiously wrought Frame, often abused and disordered, by repeated Irregularities of many kinds: But never before to the enormous Degree that it has of late Years arrived at, by the excessive Abuse of that *Bane of human Nature, fermented distilled spirituous Liquors*: Which, by their mischievous Effects, seem to claim *Satan* himself for their Author.

485. THE unhappy Dram-drinkers are so absolutely bound in Slavery to these infernal Spirits,

VENTILATORS. 199

Spirits, that they seem to have lost the Power of delivering themselves from this worst of Bondage, which they have unhappily brought themselves into. How much then is it the bounden Duty of those who have it in their Power, to with-hold, and not hold forth, this destructive *Man-bane*, to the People committed to their Charge.

486. DR. Cheyne, in his *Essay of Health and long Life*, says, “ All People who have
“ any Regard to their Health and Lives, ought
“ to tremble at the first Cravings for such
“ poisonous Liquors : The Maladies begot
“ by them bring forth Necessity upon Necessity of Drams and Jills, till at last a
“ kind Dropsy, nervous Convulsion, a nervous Consumption, or colliquative Diarrhœa, or Flux, if not a Fever or Phrenzy,
“ sets the poor Soul free. It is observed,
“ that many mad People have been great
“ Drinkers of Drams, these fiery Spirits destroying the very tender Fibres of the
“ Brain.

487. “ DID this bewitching Poison actually
“ cure, or relieve them from time to time,
“ something might be said to extenuate the

“ Folly and Phrenzy of such a Course; but,
 “ on the contrary, it heightens and enrages
 “ all their Symptoms and Sufferings ever after-
 “ wards, excepting the few Moments after
 “ taking it down; and every Dram begets
 “ the Necessity of two more to cure the ill
 “ Effects of the first.”

488. DR. *Short*, in his *History of Mineral Waters*, p. 225, says, “ The oftener I reflect
 “ on the Mischief done by distilled Spirits,
 “ the more I am confirmed that the human
 “ Race had been happier had Drams never
 “ been known, and cannot help cordially
 “ joining with Dr. *Allen*, *Synopsis Medicin.*
 “ Article 1633, “ that the plentiful devour-
 “ ing of those Spirits, has killed as many
 “ Thousands of Men as there are Stars in the
 “ Sky. Nay ten times ten thousand have
 “ died by these more than all the rest of the
 “ Poisons whatever. Wherefore, if such
 “ Spirits deserve not the Name of Poison, he
 “ neither can learn nor conjecture by what
 “ else they should be called; for, taken in-
 “ wardly, they are detrimental to almost all
 “ Animals.”

VENTILATORS. 201

489. DR. *Linde*, in his elaborate and ingenious Treatise on the Scurvy, says, That he observed that most destructive Distemper to be much increased, even to Mortality, by distilled spirituous Liquors, which Sailors are too apt greedily to swallow down. To prevent the ill Consequences of which, Admiral *Vernon*, in his Expedition to take *Porto-bello*, very prudently mixed a good Proportion of Water with the spirituous Liquors, which had the desired good Effect on the Health and Lives of his Sailors. And Captain *Ellis* attributes to the same wise Precaution, the uncommon Success he had, in bringing home, in the Years 1753 and 1755, all his white Men, which were 34 and 36, in Health, from a *Guinea* Voyage of 15 Months. And it is with Pleasure that I hear, that it is now become a more and more general Practice at Sea, to mix Water with the distilled spirituous Liquors of all kinds: Which it is therefore the bounden Duty of all Commanders of Vessels to do, who have any Value, any Bowels of Compassion for the Health and Lives of their Sailors. In our royal Navy all distilled Spirits are forbid, and Wine wisely provided.

490. AND the like good Effect has of late Years been found at Land, in our Colonies in *America*, by mixing a much greater Proportion of Water with the Rum; whereby it is happily found to be more salutary: For when the Punch was stronger, it destroyed many. Which great Degree of Unhealthiness, as I well remember, was then attributed to the Lime-juice, being loth to accuse their too-well-beloved Rum of such pernicious Effects: But are now happily convinced by Experience, that the weaker the Punch, so much the more wholesome it is.

491. AND ought not this in reason to rouse all the Nations of the World to be in Earnest; for they have nothing more to do than to prevail with themselves to be in Earnest, in order effectually to put the same salutary Method in practice at Land. The cold, sleepy Reasons that have hitherto prevailed, to the countenancing of the contrary most destructive Practice, ought surely to be rejected with Scorn and Indignation, in a Case wherein the Welfare of Millions of Mankind is so deeply concerned: What Multitudes of Lives would thereby be saved, and innumerable Outrages,

as

VENTILATORS. 203

as Thefts, Murders, &c. prevented! To rectify which were, doubtless, a most apparently vain and fruitless Attempt, while Drunkenness is made the cheapest of all Vices: For these intoxicating, pestilent Drams, not only destroy the Health and Lives of Multitudes over the World, but also greatly tend to deprave and debase the human Species to such a degree, as absolutely to quench all Sense of Duty to God or Man, and all Power and Inclination to discharge the necessary Offices of social Life. It is therefore to be hoped, that the Nations of the World will no longer be infatuated by this enchanting Siren, but in earnest rouse themselves to find an effectual Remedy for this epidemical Plague.

492. AN eminent Surgeon informs me, that he has observed the Stomachs of great Dram-drinkers to be contracted into half the common natural Size, and to be hard, somewhat like Leather that has been held to the Fire: The Consequence of which is, Loss of Appetite, and a wasting Consumption.

493. AND accordingly I have found, by putting raw Flesh into several Sorts of distilled Spirits, viz. Brandy, Rum, Arrack, and Gin,
that

that they all in like manner harden Flesh, by their pernicious, burning, caustick Salts, which are made such by the Action of Fire on them in Distillation, in the same manner as Saltpetre, from a mild, wholesome Substance, is, by the Action of Fire in Distillation, made *Aqua Fortis*, one of the rankest Poisons, its Salts being thereby formed into Darts and Spears, which tear not only animal Substances in Pieces, but also the hardest and most solid Metals: Accordingly I have been informed by Distillers here, and by Planters in *America*, that the more of the Action of Fire these Spirits have undergone in Distillation, so much the more corrosive and unwholesome they are; which is remarkably true of the later Distillations of Rum, called low Wines, which kill many of their Poor, and of the Slaves, who drink them on account of their Cheapness. Arrack is also very destructive in the *East-Indies*.

494. It appears from Admiral Knowles's Orders to restrain the Use of Rum at *Cape-Briton*, which I have seen, that they got drunk with it at the rate of a thousand a Day, and that 1400 *New-England* Men were, in two Months, killed by it.

VENTILATORS. 205

495. THE *Baron de la Honton*, in his Travels, Vol. II. Page 147. *French* Edition, says, "That distilled spirituous Liquors make
" terrible Havock among the People of *Ca-*
" *nada*; for the Number of those that drink
" it far exceeds that of those who abstain
" from it. The Havock and Destruction
" which it makes among them is so inex-
" pressibly great, that it will exceed the Be-
" lief of all who are not Eye-witnesses of it.
" It extinguishes their natural Heat, and
" makes them languid, spiritless, and con-
" sumptive: They look pale, livid, and
" frightful as Skeletons."

496. Governor *Belcher's* Lady, of *New-Jersey*, wrote me, that Rum being very cheap there, the People are so attached to it, that in Harvest-time they make it their Bargain to have every Man a Pint a Day, besides Wages.

497. DR. *Watts*, in his Book on Self-murder, says, that the Inscription on Dram-drinkers Graves should be, *Here lies a Self-murderer.*

498.

498. NOTWITHSTANDING the Destructiveness of these distilled spirituous Liquors is so notorious, that not only every open willing Eye, but even the wilfully Blind, cannot but see the Miseries that they bring on Mankind; yet how does this enchanting *Siren* bewitch and infatuate the Nations of the Earth with its Sorceries, insomuch that Multitudes of unexperienced fresh Dram-drinkers are daily crowding on to taste of the invenomed Cup. And will not this Infatuation of the Nations, in all Probability, greatly tend to hasten, with an accelerated Speed, the filling up of the measure of the Iniquity of the *Gentiles*?

499. It is pretended that Drams comfort, warm and defend from the severe Cold to which Men are sometimes exposed, without which, they say, they should perish with Cold; which is probably, in a great measure, true of those who are much habituated to drink them: The Blood of such being thereby so much impoverished, that it is well known many of the habitual Drinkers of Drams are cold and lifeless in the midst of Summer, without frequent fresh Draughts of it; this is what some of them have owned to me. But, on the other hand, how much abler are sober
Per-

Persons to endure Cold and Hardships! Their vital Heat, not being extinguished with Intemperance, does by its kindly genial Warmth, more effectually secure them from the Inclemency of Weather, than the false Flash of that which a Dram gives. Besides, it is well known that Men did not perish in the coldest Countries for want of Drams formerly, when they were not to be had. Of the undoubted Truth of this Captain *Ellis* gives a full Proof, in the Account of his Voyage to *Hudson's Bay*, Page 199. Where he observes, That the Natives on the very cold Coast of that Bay, to whom the *French* are kinder than to sell distilled spirituous Liquors, are tall, hardy, robust, and active: “Whereas those of them
“ that are supplied with Drams from the
“ *English*, are meagre, dwarfish, indolent
“ People, hardly equal to the Severity of the
“ Country, and subject to many Disorders.”

500. AND as to the pernicious Effects of spirituous Liquors in very hot Climates, as on the Coast of *Guinea*, it is observed, that the *French* and *Portuguese*, who do not indulge in distilled Spirits, are very healthy there; but that the *English*, who drink Spirits, die fast. Thus also it is observed of

the *Women* in *Barbados* and *Jamaica*, that being sober they live long; but it is not so with the *Men*, who are more generally intemperate.

501. SINCE then the Evil is become so notoriously epidemical, as to debilitate and destroy Multitudes in most Parts of the World, how destructive must it be to the real Welfare of those Nations where it rages! It behoves therefore all who have any Bowels of Pity for their Fellow-creatures, to do their best to deliver them from it. Such weighty Considerations ought therefore, in all reason, to rouse the Governors of the Nations, as tender Fathers, to use their utmost Endeavours to deliver the People committed to their Charge, from this mighty Destroyer. Can there be any Considerations of sufficient Weight to the contrary? Is it sound Policy to encourage Vice in the People because a present Revenue arises from their Debauchery? Where will the Revenues be, when the People, who should pay them, are destroyed? Are not a hardy, industrious, healthy People always found to be the ablest to contribute amply to the Support of Government? And will not Temperance, in the End, be found

a more effectual Means to increase the real Wealth and Strength of a Nation, than to make Drunkenness the cheapest of all Vices? A Vice which can no otherwise be effectually prevented from raging with its present excessive Enormity, and spreading Devastation all around, but by making it so expensive as to put it absolutely out of the Reach of the great Number of insatiable thirsty Dramists, or so weak as to be less hurtful.

502. IT is well known that many of those who keep publick Houses shorten their Lives by intemperate drinking: The common Plea for which is, that they are obliged to do it, in order to get a Livelihood; or, in other Words, to kill themselves in order to live. And is not this the very Case of those Governments who debilitate and destroy the Strength and Vitals of a Nation, in order to be Gainers by this national Temptation to *do Evil, that Good may come of it.*

503. BUT if the Consideration of the Inhumanity of being instrumental to the Destruction of Multitudes, and in a manner, in some Parts of the World, of whole Nations, is not of Weight enough to influence; yet

sure the awful Consideration that it must needs be highly displeasing to our merciful Creator, to have his favourite Creature Man thus debased, disgraced and destroyed, both in Body and Soul, ought to have its due Weight. Can it in reason be expected, that he will always stand by an unconcern'd Spectator of such astonishing Proceedings? And will he not in Mercy visit the Nations for these Things, to prevent the still much greater Ruin of future Generations; in conformity to God's usual Methods of Proceeding, when Irregularities are arrived to great Excess. And this Disease is now arrived to so enormous a Pitch, that 'tis much to be feared, nothing less than his severe fatherly Correction, will effectually cure it in many of the Nations; who seem as supine and unconcerned about it, as if only so many Thousands of Chafers or Locusts were destroyed thereby: For if in 50 or 60 Years this destructive *Pest* has spread thus far and wide, how vastly greater will the Havock among Mankind be in an hundred Years more, if some Check be not put to its Career.

504. If it had been said an hundred Years ago to any of the Rulers of the Nations, that they should patiently, and even unconcernedly
see

VENTILATORS. 211

see such Multitudes of their Subjects destroyed, both Body and Soul, and that only for sordid Lucre, would they not with Indignation have said, as *Hazael* did to *Elisha*, *2 Kings* viii. 13. *But what! is thy Servant a Dog, that he should do this great Thing?* The plain Truth is, that it is with Nations as it frequently happens to private Persons, that when they grow gradually from bad to worse, they at the same time grow more and more hardened, so as to be even reconciled to Practices for which they had at first the utmost Detestation and Abhorrence; for Familiarity takes away our Attention, and robs things of their Power to strike strong upon us.

505. THOUGH Thousands and ten Thousands perish yearly by Drums, yet no Man layeth it to Heart, except the Heads of the poor wild *Indians* and *Mohawks*, near *New-England*, *New-York*, *Virginia*, and other Parts of *North-America*; who being sensible of the great Destruction made among them, by distilled spirituous Liquors, have long since, and do still continue earnestly to desire that no Rum should be sold to their People. I am credibly informed, that it is no uncommon Thing in *North-America* for habitual Dram-

ists, when Sickness comes on them, concluding it will be their last Illness, to desire to have plenty of Rum by them, that they may continue till Death in an intoxicated Condition ; to so astonishingly deplorable a sottish Condition have they reduced themselves, by habitually indulging in this Man-bane. Alas ! how astonishing a Calamity is this, which is vastly greater than the Sum total of all the other Miseries that ever beset unhappy Man : It being both a moral and a natural Evil ; both debasing and depraving the Morals, and shortening and destroying the Lives of Multitudes, probably not less than a Million yearly all over the World ; notwithstanding which, this enchanting Liquor so infatuates the Nations, that nothing less than an extraordinary Hand of Providence can deliver Mankind from this favourite, much-beloved, mighty Destroyer. Were but one-fourth of this Number yearly destroyed by raging Pestilence, with what earnest, ingemminated Supplications, would Mankind deprecate so terrifying and sore an Affliction. How severe a Judgment is it when God leaves Men to be their own Scourgers ! with how unrelenting and unmerciful a Heart do they perpetrate an Evil that ought to be de-

VENTILATORS. 213

deprecatèd both in publick and private, with ingemminated Petitions !

506. Thus much Necessity has urged me to speak, in a case so calamitous to Mankind, that to have a thorough Sense of it, and yet not to remonstrate, nor earnestly precaution against it, were sure as criminal as not friendly to warn a precipitate or blind Person of a dangerous Precipice or Pit. Yet, alas ! how unconcerned are the greatest Part of Mankind at this most enormous Ruin of Multitudes, in many Nations of the World. Thus, in *Russia*, a vast Revenue is raised from distilled spirituous Liquors, and a proportionably immense Multitude of People are destroyed thereby.

507. As this greatly interesting Affair requires the exerting the utmost Efforts to rouse the Attention of Mankind to the serious Consideration of it, I shall here add an Extract from a printed *Address to an eminent Person, upon an important Subject*, viz. “ Ask those
“ in Stations of Power and Trust, ask them
“ if they can look with Indifference upon
“ their poor distracted Countrymen, who are
“ poisoning and destroying themselves ? In
“ Trials for Life, what Diligence is not used

“ to find the Truth, on occasion of the Loss
“ of one Subject? What Care will not a
“ faithful Physician bestow for the Preserva-
“ tion of one Life? How did the wise Ro-
“ mans honour him who saved the Life of
“ one *Roman* Citizen? But in the present
“ Case, it is not one, nor one hundred, nor
“ one thousand, but many thousands of Lives,
“ probably not less than a Million, that perish
“ yearly over the World, by this worst of
“ Pests.—How then dare the Governors of
“ the Nations be silent or unconcern’d in a
“ Cause in which Humanity, Virtue, the
“ Prosperity of Mankind, and Religion, are
“ so deeply concerned? for whatever tends
“ not only to the weakening the Faculties,
“ enervating the Bodies, and of course, di-
“ minishing the Industry of Labourers and
“ Artificers of both Sexes, but also to the pre-
“ venting the Birth of thousands, destroying
“ many Infants, to the greatly debasing the
“ Breed of Man, and shortening the Lives of
“ Multitudes. Whatever produces Effects
“ of these Kinds, must bring irretrievable and
“ final Ruin on those unhappy Nations where
“ this destructive Pest rages. Ought not
“ then a Stop to be put to this dreadful Ca-
“ lamity, before it be too late, *by any Means,*
“ and

“ *and upon any Terms whatsoever*, in those
 “ Nations where they mean to keep up any
 “ Face of Government? Nor can there be
 “ any Inconvenience like to arise from the
 “ Redress of the Grievance, that deserves to
 “ be named with those Evils which must be
 “ the undoubted Consequences of its Con-
 “ tinuance.”

508. IF all these weighty Reasons will not rouse a careless World into a Sense of Self-preservation, enough to put Men upon avoiding so certain and terrible a Destruction, they are then surely under a strong Delusion and Infatuation, and consequently abandoned to suffer the severe Punishment, of reaping the unhappy Fruits of their own perverse Ways. The calamitous Urgency of the Case absolutely requires the most pathetic Expostulations, to rouse the Attention and Indignation of Mankind against this greatest of all Plagues that ever befel unhappy Man; it being both our Sin, and the severest of Punishments, which Mankind have most senselessly inflicted on themselves.

509. A VERY eminent Physician, of great Knowledge and Experience, has given the fol-

lowing Directions, for the Benefit of those who have Wisdom and Virtue enough left to abandon the odious and pernicious Practice of drinking distilled spirituous Liquors, *viz.*

510. " ONE of the best Ways of leaving
" off the bad habit of drinking Drams is, by
" degrees to mix Water with the Drams, to
" lessen the Quantity of the Dram every
" Day, and keep to the same Quantity of
" Water, till in about the course of a Week,
" nothing of the Dram-kind be used along
" with the Water. By this means the Per-
" son will suffer no Inconvenience, but reap
" great Benefit upon leaving off Drams; as
" has been tried by many.

511. " If any Gnawing be left in the Sto-
" mach upon leaving off Drams, a little hot
" Broth is a very good Remedy.

512. " THE Appetite always increases in
" a few Days after leaving off Drams, unless
" by the too long Continuance of them, the
" Tone of the Stomach is destroyed.

513. " IN which melancholy State, the best
" Remedy, next to the *Bath Water*, is the
" fol-

VENTILATORS. 217

“ following, *viz.* Take an Ounce of *Elixir*
“ *Proprietatis*, three Drams of *Elixir of Vi-*
“ *triol*, and one Dram of *Minsicht's Elixir of*
“ *Steel*; mix these together, and let the un-
“ happy Sufferer take a Tea-spoonful in a
“ small Wine-glass, full of White-wine, if
“ that can be afforded, or else *Wormwood Ale*,
“ or a Cup of *Carduus* or *Camomile Tea*,
“ every Morning fasting, and every Evening.”

514. I SHALL here add a Panegyrick on
Temperance, from Dr. *Short's History of Mi-*
neral Waters, Page 9. a Panegyrick worthy
to be recorded in every one's Memory, *viz.*
“ O Temperance! thou Support and Atten-
“ dant of other Virtues! thou Preserver and
“ Restorer of Health, and Protractor of Life!
“ thou Maintainer of the Dignity of rational
“ Beings from the wretched, inhuman Sla-
“ very of Sensuality, Taste, Custom, and Ex-
“ ample! thou Brightener of the Under-
“ standing and Memory! thou Sweetener of
“ Life and all its Comforts! thou Companion
“ of Reason, and Guard of the Passions!
“ thou bountiful Rewarder of thy Admirers
“ and Followers! How do thine Excellencies
“ extort the unwilling Commendations of
“ thine Enemies! And with what rapturous
“ Pleasure

“Pleasure can thy Friends raise up a Panegy-
 “rick in thy Praise!”

515. VENTILATORS will probably be of good Service for preserving Herring-nets in stormy Weather, when they are obliged to stow the wet Nets in Heaps in the Ship, which causes them to decay much: Which Inconvenience may, in a good measure, be prevented by blowing several Times in a Day, fresh Air up through them, through very small Air-trunks placed on the Floor, at three or four Feet distance, with their four Seams opened about a Quarter of an Inch; the fresh Air to be blown in by a small Ventilator, about the Size of that Fig. 6.

516. AND in the same manner the Nets may most effectually be preserved much the longer from decaying in the Store-houses, by such large double Ventilators as are in *Newgate*, worked by a Wind-mill. And as they may be laid of any Depth on the Air-trunks, on the Floor, much less Expence of Store-house-room will do. Perhaps it may be adviseable to have Layers of Hurdles, or small Faggots, every three or four Feet, among the
 Layers

VENTILATORS. 219

Layers of Nets, to give a free Passage for the Air upwards.

517. THERE is a common Fault in most Pigeon-houses, *viz.* that the fresh Air is admitted to enter only at the upper Part of the Roof; by which means the foul, fœtid Vapours of a great Quantity of Dung, and the perspiring Matter from great Numbers of them, being too close confined, putrifies and incommodes both the Hatching and Thriving of Pigeons. *Monf. de Reaumeur* observes, in his Treatise on hatching of common Hen-eggs, that if the foul Wreak of the Dung, by the Warmth of which they were to be hatched, came at the Eggs, then they would not hatch. Now this Inconvenience may be prevented by making Holes in the Side-walls, at such a Height, that Men or Cattle going by shall not fright them; or by Holes in the Walls slanting upwards, or a Board within, at a small Distance opposite to the Hole.

518. DR. *Langrish*, of *Winchester*, used this Method to a new-built Pigeon-house at *Petersfield*; where Pigeons did not breed till Air-holes were made in the Side-walls: And I have known several Instances of Pigeon-houses,

houses, where they have bred more, and have thrived the better for having fresh Air admitted through the Walls. Nor need any be apprehensive lest by this means, the Pigeons should be exposed to too much cold: It is well known that tame Pigeons thrive very well in their Nests on the Outside of Houses, where they are exposed to much greater Degrees of Cold, and inclement Air.

519. In order to preserve great Quantities of Corn in large Granaries, it may very commodiously be done in the following Manner, *viz.* by fixing large double Ventilators, laid on each other, at the Middle and near the Top of the Granary, that they may be worked by a Wind-mill fixed on the Roof of the Granary: But a Water-mill will be much better, because it will work the Ventilators more constantly. The Air to be conveyed from the Ventilators through a large Trunk or Trunks, reaching down through the several Floors to the Bottom of the Granary, with branching Trunks to each Floor, to convey the Air into a large Trunk along the adjoining Cross-walls; from which Trunks several lesser Trunks, about four Inches wide, are to branch off, at the Distance of three or four Feet

VENTILATORS. 221

Feet from each other, which are to reach the whole Length of the Granary, and are to have their farther Ends closed; Seams of one-tenth or one-twelfth of an Inch, are to be left open at the four Joinings of the Boards, where they are nailed together, for the Air to pass through among the Corn, putting small Slices of Wood in, or old Sole-leather, at proper Distances, to keep the Seams open. The Trunks which are next to the Side-walls ought to be something nearer to the Walls than they are to the next adjoining Trunks, that the Corn next the Walls may have its due Proportion of Ventilation. But if the Corn does not lay against the Side-walls, then only one, or very few of those smaller Trunks will suffice, more or less, in proportion to the Breadth of the Granary; and they may in this Case be the more distant from each other. Mr. *Yeoman* has by Experience found this a good Method to preserve Corn.

520. AND as all the small Trunks of a Granary will not probably be covered with Corn at once, so it will be proper to have sliding Shutters to each of these lesser Trunks, where they branch off from the larger Trunk, in order to stop the Passage of the Air through
the

the Trunks which are not cover'd with Corn; or in case all are cover'd with Corn, to ventilate the more briskly one Part of the Granary which may want it more than the other; in order to which, it will be requisite to have long Rods, reaching to the Sides or above the Corn, fixed to the sliding Shutters.

521. THERE must be wooden Shutters hung on Hinges at their upper Part, so as to shut close of themselves; these must be fixed to the Openings in the Walls of the Granary, on their Outside: By this means they will readily open, to give a free Passage for the ventilating Air which ascends through the Corn, to pass off, but will instantly shut when the Ventilation ceases, and thereby prevent any Dampness of the external Air from entering: For which Reason the Ventilation ought to be only in the middle of dry Days, unless the Corn, when first put in, is cold and damp.

522. I LAID a long Trunk on a Barn-floor, about five Inches wide in the Clear within; the four Seams were about one-tenth Inch wide, for the Air to pass through the whole Length, the further End being closed; a
large

VENTILATORS. 223

large Heap of Corn was laid on it, through all Parts of which the Air from the small Ventilators, (*Fig. 6.*) passed freely; as was evident by the Motion of a light spread Handkerchief laid on any Part of it. This seems, therefore, to be a commodious and cheap Method to ventilate Corn in large Granaries, *viz.* by laying such a Trunk on the middle of the Floor, the whole Length of the Granary; and if the Granary is very long, it will be well to have the Air from the Ventilators enter the Trunk at its Middle; by which means either the whole Granary, or but one-half of it, may be ventilated at a time. But in this Method of ventilating with one Trunk, the Corn must not lay against the Side-walls, which would prevent the free Passage of the Air side-ways. But if in Granaries already built, at a little Distance from the Side-walls, a lattice upright Fence, about five Feet high, is fixed; this Fence to be lined with loose wove Hair-cloth, for the Air to pass through; then very great Quantities of Corn heaped high, may by this means be well ventilated: And the Floors may be effectually supported from being broke down, by the Support of upright Posts; but boarded Ground-floors will be best, where great Depths and

Quan-

Quantities of Corn may thus be preserved good, with little Expence in the Building of Granaries, *viz.* by building them with the Side-walls only about twelve Feet high. 4, 4, Fig. 23. 6. 6. the Rafters of the Roof, with a boarded Ground-floor to lay the Corn on. 8. 8. 8. With upright lattise Fences *b. a. d. e.*, five Feet high. The Fence *d. e.* to be three Feet distant from the Wall *z*, for Room for Men to walk to and fro: But the Fence *b. a.* to be only four Inches distant from the opposite Wall *x*. These Fences to be lined within side with Hair-cloth, for the ventilating Air to pass through side-ways as well as upward, from the Air-trunk *o*; which lays at the Bottom of the Corn *a. e. c.*, the whole Length of the Granary: This Trunk to be eight Inches wide in the Clear within, with both Ends closed. The four Seams of the Trunk *1. 1. 1. 1.* to be open one-tenth Inch diameter, and to be fixed so by means of thin Slips of Wood, or of Sole-leather, about a Foot distant from each other.

523. THE lattise Fences to be retained from swerving outward, by the Force of the Corn, by a slender Cross brace *b. d.*, with a Dove-tail-fastening at each End: And the

VENTILATORS. 225

whole to be fixed from swerving side-ways, by the reclining Braces 3 3.

524. Now, supposing the Distance of the lattice Fences from each other to be 16 Feet, then there will be eight Feet Breadth of Corn on each Side of the Air-trunk *o*: And when the Space between the Fences is not only filled with Corn, but also heaped up to *c*, then the Depth of the Corn from *c* to the Bottom will be eight Feet. And it will be well to bring the Distances of the Sides and Top of the Corn to be thus nearly equal, from the Air-trunk *o*; that the ventilating Air, meeting with equal Resistance from equal Quantities of Corn, may thereby be the more equably diffused through all Parts of the Corn; the Interstices among Wheat, for the Air to pass through, being one-seventh of the Space that the Corn fills up.

525. WHEN the Corn is first put in, let it be heaped up as high as may be upon the Air-trunk *o*; and the same to be observed in taking away the Corn from the Sides, leaving the Air-trunk covered to the last.

526. WHEN only a Part of the Trunk is cover'd with Corn, it will be well to have a sliding Shutter, to stop the Air from passing on to the uncovered Part of the Trunk.

527. AND when the Part of the Trunk is uncovered towards the End at which the Air enters, then the open Seams of that Part ought to be closed on the Outside, with long smooth Laths, about half an Inch thick, and an Inch and half broad ; to be retained in their Place by small Iron Hooks, or rather with small Pieces of Wood, with Notches or Grooves in them.

528. Two Pair of double Ventilators, with Midribs ten Feet long, and four and half Feet broad, to be laid on each other, on two Beams, in the Middle of a Granary 100 Feet long, if they are worked by a Wind-mill fixed on the Granary: But if they are worked by Water, which is much the best Way, then the Air may be conveyed through a subterraneous Trunk a Foot within, from the Ventilators to the Middle of the long Air-trunk, under the Corn.

VENTILATORS. 227

529. THERE must be wooden Shutters to cover on the Outside, the Holes in the Side-walls of the Granary hung on Hinges at their upper Part, so as to close down of themselves: By this means they will readily open to give a free Passage for the ventilating Air, which ascends through the Corn, to pass off; but will instantly shut when the Ventilation ceases, and thereby prevent any Dampness from the external Air from entering: For which Reason the Ventilation ought to be principally in the middle of dry Days, unless the Corn when first put in, is cold and damp, so as to be in danger of heating and growing musty.

530. Mons. *du Hamel* mentions, in his Book on this Subject, that the most frequent Ventilation is requisite at first; but that after some time a little Ventilation will suffice.

531. By this means he preserved a Heap of Wheat, sweet and free from Weevils and Insects, for seven Years, without turning it: For the Eggs of Insects are observed to be hatched principally when the Corn heats; which heating is effectually prevented by Ventilation.

532. ABOUT 8000 Bushels of Corn may thus be preserved, in a Granary 100 Feet long, between latice Fences five Feet high, and 16 Feet distant from each other; and this without building a large Granary; and much more Corn may be thus preserved in a Granary a little wider, and with latice Fences, more than five Feet high.

533. IN order to preserve Corn from being eaten by Rats and Mice, it may be well to nail, on the upper Rail of the latice Fences, sloping Boards coving over to prevent their getting up. It is said that Rats and Mice will not gnaw Holes through Hair-cloth; but if they do, then it will be well to put Brass or Iron Wire-work between the Hair-cloth and the latice Fence.

534. IN Ships Corn may be ventilated, by laying thin Hurdles, or Reeds, to the Sides of the Ships, cover'd with Mats, for the ventilating Air to pass through. And in the same Manner Corn may be ventilated in Bins.

535. AND in the Case of very cold, damp, musty, or wasked smutty Wheat, there may be

VENTILATORS. 229

be a proper large Bin, in an Apartment to lay it in, where it may have a great Force of ventilating Air given it.

536. IN leffer Granaries, where the Ventilators must be worked by Hand, if these Granaries stand on Staddles, so as to have their lowest Floor at some distance from the Ground, the Ventilators may be fixed under the lowest Floor, between the Staddles, so as to be worked by Men standing on the Ground, on the Outside of the Granary, or within it.

537. IN Granaries full of large Bins, the Corn may be ventilated either by applying the small moveable Ventilator, *Fig. 6.* but a Size larger than those, to each Bin; or by one Pair of double Ventilators, *Fig. 2.* so placed as to blow Air through an Air-trunk fixed in the Front of the Bins, whence Air may be conveyed to any one, or several of the Bins at once, through Side-holes communicating with the leffer Air-channels of each Bin; which Holes are to be opened or shut with Sliders, as Occasion requires.

538. CORN may thus be kept sweet and dry, with little Expence of Ventilation, and

that chiefly at the first laying the Corn in. I believe it will be best to ventilate when it first begins to sweat a little, because the Moisture being then afloat in the Air among the Corn, and on the Surface of the Grains, it will be carried off with less Ventilation: And when this has thus been repeated a few Times, the Corn will effectually be freed from the greatest Part of the Moisture, which would indanger the Spoiling of it, or the Breeding of Weevels, which is much promoted by the Heating of Corn. And when it is by this means become compleatly dry, it has been found by Experience, that very little Ventilation will afterwards be required; especially if in this dry State the Windows and all Inlets of Air be kept close shut, in order to prevent the Entrance of the Air in a damp State: But in a very dry State of the Air, it may be well to open them sometimes in the middle of the Day; for a fresh dry Air is better than a dry, long confined Air. Ventilation will be more requisite to keep Corn and Bread sweet in a hot damp Climate, than in a cold damp Climate, *viz.* because Heat promotes Putrefaction.

VENTILATORS. 231

539. IT is matter of great Consequence to keep Corn sweet and dry, not only for the sake of the Value of the Corn, but more especially for the sake of those who are to eat it: For Dr. *Pringle* observes, that mouldy, putrefied Grain, is apt to produce malignant Fevers: And that Corn kept in a damp Granary, is apt to produce a Dysentery in the Poor, who live chiefly upon it.

540. ALL Kinds of Corn, Seeds, or whole Oatmeal, may thus be kept sweet by Ventilation: And probably also Coarse-ground-oatmeal; for I have found the Air pass upwards through about six Inches Depth of fine Ground-oatmeal, and that in a small Degree when it was pressed down. But I know not whether it will go through a great Depth of fine Ground-oatmeal, where it will be pressed down by its great Quantity. It may probably be a good Method to prepare Oatmeal to be laid up in Quantities in large Store-bins; by first ventilating it in a Bin, with a false Bottom of proper thin-wove Canvas; laying it there of such a Depth only, as shall be found by Experience proper for Air to pass up freely through it. The Air will not pass through Wheat-meal, notwithstanding it takes up

much more Room when ground than underground. Air passes freely through ground Malt.

541. IN order the better to judge when the Air is in a damp or a dry State, it may be well to have a Cord with a long Rod fixed like a Lever in a proper Manner; by the rising and falling of one End of which the State of the Air may be pretty well known. Great Care must be taken not to ventilate dry Corn in a damp State of the Air; but damp Corn must be ventilated in a damp Air. By Ventilation Corn may be made fitter for Use sooner after Harvest, than it would otherwise be. Corn may be most commodiously and effectually ventilated in Ships, by laying two or three Trunks on the false Floor of the Ship; which is made in some Corn-ships to preserve Corn from the Bilge-water: The further Ends of the Trunks to be closed: But all their four Seams to be opened about one-tenth or one-twelfth of an Inch, for the Air to pass through among the Corn. This will be much the best Method to ventilate Corn in Ships, by laying it thus on a Floor of Boards.

VENTILATORS. 233

542. BUT when it lays loose on Faggots covered with Mats, it may be done by placing two or three long Trunks, about six or eight Inches wide, among the Corn; about one-third of the whole Depth of the Corn from the Bottom of it: The Trunks to be about the Width of the Well distant from each other. The Ventilators to be fixed on the lower Deck, at the Fore-part of the Ship; whence the Air is to be conveyed by two Trunks to the above-mentioned long Trunks. These two shorter Trunks must have their Seams closed, and also a short Joint of Leather, that they may the better comply with the Sinking of the long Trunks, occasioned by the Weight of the Corn.

543. WHEN Corn is carried in Bags, if the hot, frowzy Air is frequently drawn out of the Hold, the Corn will doubtless keep much the better for it, especially if the Bags have small Brush-wood-sticks laid between them, so as to prevent their touching one another, and thereby leaving Vacancies, though very narrow, for the Air to pass freely between them, when the Ventilators are drawing it off. By this means the Corn in each Sack would be kept in a manner almost as well, as
if

if each Sack stood single in a Room. Experience will doubtless give Hints for further Improvements in these Things.

544. Now, suppose there be 1000 Quarters of Wheat in a Ship; since every five Quarters, or 40 Bushels, take up fifty and half cubick Feet, then 1000 Quarters will take up 252.5 Tuns of Stowage; one-seventh Part of which, *viz.* 34.6 Tuns, being Vacancy for Air among the Wheat, a Quantity of Air equal to that, will be drove through the Wheat in much less than two Minutes Ventilation, by a Pair of Ventilators, whose Midribs are each seven Feet long, and three Feet wide. The Vacancy for Air among Oats, is about one-third of the Space that any Quantity of them take up: And among Peas and Beans it is very large; so that any kind of Corn may thus most easily be kept sweet.

545. Now, in order to prove whether all the Corn in a Ship or Granary is ventilated, take a Cask with only one Bottom, and set it upside-down, on any Part of the Corn; if a lighted Candle be held to a Tap-hole in its Side, the Motion of the Flame will shew the
Force

VENTILATORS. 235

Force of the Air which passes through the Corn by Ventilation. Though Ventilation of Corn in Ships will always be useful, in order to keep it sweet, and the freer from Weevils, yet it will be most serviceable in time of War, when they often wait long for Convoys.

546. QU. May it not be adviseable to destroy all the Rats and Weevils in a Corn-ship, by strong Fumigation with burning Brimstone, laid in Basins made in the Ballast, before the Ship is loaded with Corn: And if while the Ship is loading with Corn, a little Brimstone is burnt from time to time, as it is filling, this will be a probable Means to prevent the Breeding of Weevils, and will give no ill Taste to the Corn.

547. I AM told by an experienced Person, that Ventilators would probably be very serviceable in the Cod-fish Ships, where they lose much Fish by the Closeness of the Hold, notwithstanding they are continually moving the Fish to and fro.

548. SIR *John Philips*, of *Piñton Castle*, in *Pembrokeshire*, informed me, that in the Year 1750, some Ships laden with Cheese,

being Wind-bound for some Months at *Milford-haven*, the Cheese were much damaged by the great Heat of the Hold, except in one Ship, which had Ventilators, which preserved them well.

549. I SHALL here insert a short Account of several curious Experiments and Observations, from *Monf. du Hamel de Monceau's* Treatise on preserving of Corn, which he sent me, *viz.*

550. HE observes, that Wheat is the most difficult of all Grains to preserve; that which is cold and damp having one-eighth Part of Moisture in it: That they are obliged to have large Granaries to preserve small Quantities of Wheat, because it can lay but 18 Inches deep: And the Corn of a wet Harvest must be turned every third or fourth Day; and yet be subject to be destroyed by Weevils and other Insects. Whereas in the way of Ventilation, it may be laid in Heaps of a great Depth; and the more so the drier it is.

551. I BELIEVE that subterraneous Granaries, lined with Lead to preserve from damp, might be made at a cheap Rate, considering

VENTILATORS. 237

the vast Quantity of Corn they would contain, and their very little want of repairing many Years: They might most easily be ventilated when needful, by small Air-trunks laid at a due Distance at the Bottom of these Granaries; where the Corn would be secure from Mice and all Kinds of Insects.

552. MONS. *Dubamel* put 94 cubick Feet, or 75 Bushels of well-cleaned Wheat, into a Box of Oak, which was the Cube of five Feet, with a false Bottom to it, when it was ventilated with Ventilators worked by the Hand, for the first three Months eight Hours every fifteenth Day; the rest of that Year, and the following Year 1744, it was ventilated but once a Month. In the Year 1745 and 1746, it was ventilated but half a Day every Month; and afterwards only every two or three Months. In the Year 1750 he took the Corn out of the Granary, when it both looked and smelt well, but was rough to the Hand, because, not having been moved in seven Years, the Beards at the End were rough; but having cleansed and ventilated it, there was no Fault in it: There were no Weevils or other Insects in this Corn: The Bakers who bought it, and did not know how, nor how long it
was

was preserved, gave more for it than for any other Corn in the Market; they observed, that it produced very good Flour, soaked up more Water in its Paste, and yielded more Bread than any other Corn in the Market.

553. THE Wheat of the foregoing Experiment being very good conditioned, he took 75 cubick Feet of very cold and damp Corn, of the Year 1745, which in the common Way of keeping, by turning, soon heated and had a bad Smell; which he had little Hopes of preserving by Ventilation, as it was hot when put into the Granary: It was ventilated three or four times a Week the first Month, and every eighth Day, during *December* and *January*. As it was now grown fresh, and had lost some of its ill Smell, the next four Months it was ventilated every fifteenth Day. At this time the upper Part of the Corn began to heat; but when that was taken away for a Foot depth, the Remainder was drier than that in common Granaries, and had but little ill Smell; more frequent Ventilation would have prevented this Dampness and Heat of the upper Corn.

VENTILATORS. 239

554. IN the Year 1750, *Monf. du Hamel* fixed a Windmill upon a large Granary, to work Ventilators: And in one Part of the Granary laid 555 cubick Feet of very damp Wheat of the wet Year 1751, being first well cleaned from Smut, &c. It was laid between four and five Feet deep in the Granary. The Wind served very well the whole Year 1751, and the following Spring; so that the Corn was frequently ventilated; which not only dried it, but cured it in part of its ill Smell. This Corn was covered with a dry Dust, which separated from it as it dried, which it was easily cleansed from, and then sold at the Price of the best Corn.

555. WHEN Corn was thus prepared by drying, he then laid it eight or ten Feet deep in the Store-granary, where it was to remain for a long Continuance of several Years; and if laid at much greater Depths, the ventilating Air would pass up freely through it, and a little Ventilation now and then would probably be sufficient.

556. LEST in *June*, or thereabout, there should be four or six Weeks calm, he proposes to have the Corn first cleansed, and part dried

dried in common Granaries : But if the Ventilators were made to be worked by a Horse in long Calms, then this Precaution need not be used. His other Precaution is, to dry it in some degree in a Stove or Kiln.

557. NINETY cubick Feet of well cleaned damp Wheat, being dried in his Stove, lost an ill Smell by drying, and kept well without any Ventilation : Though another Parcel of the same Corn did not lose its Smell by the Stove.

558. EIGHT hundred and twenty-five cubick Feet of Corn being in part dried in the Stove, where its ill Smell was something abated, Ventilation afterwards cured the ill Smell ; this Corn sold better than any in the Market. This partial drying on the Kiln is short, and with a gentle Warmth : But it is found that Corn thoroughly dried on a Kiln, does not make good Bread.

559. WHERE Corn can be constantly ventilated in the Day-time, it can neither heat, nor contract an ill Smell ; for this Purpose Water-mills are best.

VENTILATORS. 241

560. MONS. *Giraud*, a Merchant at *Marseilles*, informs me, that Corn will be damaged by being too much exposed to the very dry Air of that Country.

561. MONS. *Du Hamel* thinks it probable, that the Eggs of Weevels do not hatch without a considerable Degree of Warmth; which is agreeable to the Observation of many great Dealers in Corn; who have informed me, that they will not hatch unless the Corn sweats: If so, then Ventilation will effectually prevent the Heating of Corn, and consequently the Hatching of their Eggs; which he has by Experience found that it will effectually do.

562. HE says that Weevels seem dead in cold Weather, and can bear 50 Degrees of Heat on a Kiln, without being killed. And accordingly I found that, on burning many Pounds of Brimstone in a Malt-house-room, which was not so big as a Cube of 16 Feet, and abounded with Weevels, many of them were not killed by it: The Fumes of burning Brimstone among Store-corn, in a well-closed Granary, would probably prevent the Prolifickness of Eggs.

563. IN building the Walls of a Granary, I think it may be adviseable to lay a Plate of Lead on the Wall, when a little above the Ground; or two or three Course of plain Tiles, to prevent the Ascent of Moisture from the Earth.

564. MONS. *Du Hamel* observes, that the comparative Expence of his Granary to the great Granary at *Lyons*, is as 3 to 5: And that the *Lyons* Granary contains 86,400 cubic Feet of Corn: But his contains 144,000.

565. HYGROMETERS will be very useful, both in Granaries and some adjoining Building; in order both to know the State of the Air in the Granary, as also that of the external Air, thereby to regulate the properest Time for Ventilation.

566. I SHALL here mention the Size of the Midriffs of several single and double Ventilators, which Mr. *Yeoman* of *Northampton* made for several Persons, that thereby the better Judgment may be made of the proper Sizes for different Purposes, *viz.*

VENTILATORS. 243

567. 1745. A SINGLE Pair for Sir *Simeon Steward*, Bart. for a Granary; the Midriff six Feet long, and two Feet wide.

568. A DOUBLE Pair for Mr. *Walter Robertson*, of *Lynn*, for a Granary; Midriiffs five Feet by two.

569. 1746. THE like for Sir *John Philips*, Bart. of *Piñton Castle*, *Pembrokeshire*.

570. 1748. A SMALL fingle Pair for a little Granary, for *Joseph Ash*, Esq; of *Dutton*, *Northamptonshire*; Midriff five Feet by two.

571. 1752. A SINGLE Pair for *Thomas Scawen*, Esq; of *Maidwell*, *Northamptonshire*, for a small Granary; Midriff eight Feet by two.

572. IT has been found a good Method, in order to have these fingle Ventilators work the easier, not to lift up the Midriiffs at the End, as in Fig. 6. but to fix one End of a Lever to the Iron Rod; which Lever resting on an upright Stand, the Midriff was then raised and depressed by working the other End of the Lever up and down.

573. THE following Method for preserving Corn sweet in Sacks I published in the Newspapers, and in the Gentleman's Magazine for *July*, 1745, believing it would be of great Benefit to the Poor, who frequently keep small Quantities of Corn by them in Sacks; where it is often spoiled, and then makes bad and very unwholsome Bread.

574. PROVIDE a Reed-cane, or other hollow Stick, made so by glewing together two Sticks grooved hollow; let it be about three Feet nine Inches long; and, that it may be the easier thrust down to the Bottom of the Corn in the Sack, its smallest End is to be made taper to a Point, by a wooden Plug that is fixed in and stops the Orifice. About 150 small Holes, of one-eighth of an Inch in diameter, are to be bored on all Sides of the Stick, from its Bottom to two Feet ten Inches of its Length, but no nearer to the Surface of the Corn, lest too great a Proportion of the Air should escape there. By wreathing a Packthread, in a spiral screw-like Form round the Stick, the Boring of the Holes may be the better regulated, so as to have them about half an Inch distant towards the Bottom, but gradually at wider Distances, so as to be an
Inch

VENTILATORS. 245

Inch asunder at the upper Part; by which means the lower Parts of the Corn will have their due Proportion of fresh Air. To the Top of the Stick let there be fixed a leathern Pipe, ten Inches long; which Pipe is to be distended by two Yards of spiral Wire coiled up within it. At the upper Part of the Pipe is fixed a taper wooden Fawcet, into which the Nose of common Household Bellows is to be put: Common large Kitchen-Bellows convey about three Pints of Air; but supposing it to be but a Quart of Air, then at the Rate of 64 Strokes in a Minute, they will convey a Quantity of Air equal to the Capacity of a four Bushel Sack, in two Minutes. And since one-seventh Part of the Space that Wheat takes up, is the Quantity of Meanders among the Corn, which are full of Air, a Quantity of fresh Air equal to it will be blown in among the Corn with less than twenty Strokes. So that if Corn, when first put into Sacks, be thus aired every other or third Day, for 10 or 15 Minutes, its damp Sweat which would hurt it, will in a few Weeks be carried off to such a degree, that afterwards it will keep sweet with very little airing, as has been found by Experience. But if Corn be got stale by standing long in Sacks without airing,

it would be too much Work to attempt to sweeten it by this Method; it is therefore best thus early to prevent the Staleness.

55. WHEN many Sacks of Corn are thus to be preserved sweet, it may be well to have much larger Bellows, with wider Noses; for the wider the Noses, they may be worked both the easier and the faster. And if the Sacks are placed so that Cats can go between them, it will prevent the Mice from eating them.

576. BY the same Means, many other Kinds of Seeds as well as Corn, may be kept sweet, either in Sacks or small Bins; but then, in Bins the Air-holes must be made only near the Bottom of the Canes, because the Air must in that case all ascend upwards, since it cannot go through the Sides of the Bin, as it will through Sacks. I shall here insert the Description of a very great Improvement which is made to a *Back-heaver*; which has been long used in *Hampshire*, *Wiltshire*, and *Sussex*; which will not only winnow Corn much sooner and better than by any other Methods hitherto used, but will also clean and clear it of the very small Corn, Seeds, Blacks,

VENTILATORS. 247

Blacks, Smut-balls, &c. to such Perfection, as to make it fit for Seed-Corn.

577. THIS I published in the *Gentleman's Magazine* for July 1747. This Back-heaver is four Feet long from *A* to *B*, *Plate V. Fig. 17.* and three Feet broad from *A* to *I*, and *B* to *D*. *A, B, C*, is the Head-board, three Fourths of an Inch thick, and eight Inches and half deep within; *B. C. D*, and *A. F. I*, the Side-boards, eight Inches deep at *B, C*, and four Inches and half at *I, F*, within; the Bottom *Z, Z*, is boarded as far as *X, X*, and from *X X*, to *I D*, the Breadth of thirteen Inches and half is Iron Wire-work. These parallel Wires are in Size about one Tenth of an Inch in Diameter, and have their Centers about four Tenths of an Inch distant from each other, their Ends being fastened to the under Parts of the Boards at *X, X*, where their Ends are covered with a List of Tin, half an Inch broad, to the upper Part of the Rail at *I, D*, that Ears of Corn, coarse Hulls, &c. may freely slide off. The Distances of the long Cross-Wires *R, R*, are three Inches from each other; they serve to support and strengthen the short parallel Wires, being

R 4 placed

placed under, and bound fast to them, with very fine Brafs-Wire.

578. *THIS* Instrument is suspended, with its Bottom about five Feet high, by strong leathern Straps fixed to the Side-boards, at *N, X, X*, near the Center of Poise or Gravity ; which Straps *M, M, N, X, X*, are buckled together at the desired Height, over the upper Rail *M, M*, which Rail is supported by the upright Posts of the Frame *P, Q*, which Posts stand seven Inches distant from the Ends of the Back-heaver ; thereby to leave room for it to be shaken to and fro. It is needful, in order to prevent the Frame from sliding to and fro on the Floor, to have strong-pointed Iron Pins, full half an Inch long, fixed in the bottom Pieces of the Frame at *S, S, S, S*.

579. *IN* order to keep the Back-heaver steady, and in its proper Degree of Inclination, a String or Strap is tied at one End to the middle of the upper Rail *M, M*, and at the other End to the middle of the fore Rail of the Back-heaver. If this String be tied to the lower Part of the Frame, which supports the Back-heaver, it will not do so well. The Back-heaver is shaken to and fro in this inclining

VENTILATORS. 249

clining Posture, by a Person who stands on a Stool, which is hooked at *T* to the upright Post of the Frame. As the first coarse Hulls and Corn, which are thrown on the Board *Z Z*, *X X*, slide down thence on the Wire, the Corn, and some of the fine Hulls drop through the Wire; the coarser Ears and Straws, &c. fall off at the lower End *F, D*, beyond the Corn; where the Wind from the Circulating Fan or Fagg, which is placed behind near *A, B*, blows it away, as also some of the Refuse from among the falling Corn.

580. BUT finding that a considerable Quantity of the smaller Hulls passed through this wide Wire Grate, I placed under that Iron Grate *X X*, *I D*, another fine Sieve, which had five square Mashers in the Space of an Inch, or twenty-five in an Inch square, the Wire being about one thirty-sixth Part of an Inch in diameter. This Sieve was nineteen Inches and half broad in the Clear; it was fixed in a Frame, *F H*, *H L*, under *L* its hinder Rail, and upon its fore Rail *H, H*. These Rails were three Inches broad, and near an Inch thick. This Sieve was strengthened and supported by two strong Iron Wires, placed lengthways; and by seven of the like Wires, placed

placed at equal Distances across them. This Sieve, with its Frame, was hooked to the Back-heaver by two flat Iron Hooks at each End, which were nailed to the Side-boards of this Frame *HF, HL*. And these Hooks are prevented from slipping down, by two small Hooks drove into the Edges of the Side-boards of the Back-heaver. This under Sieve is not fixed in a parallel Position to the upper Sieve or Grate, but inclining so, as to have its hinder Rail five Inches below the Back-heaver, and its fore Part only two Inches below the fore Rail of the Back-heaver. By this means, the under Sieve is not inclined sloping to so great a degree as the upper Iron Grate of the Back-heaver, neither ought it to be so much inclined, but is to be kept almost level, or parallel to the Horizon, lest too much of the Corn, instead of falling thro' the Sieve, by descending too precipitately over the Sieve, should run forward with the *Chaff* and *Huzzes* over the foremost lower Rail, and so not be separated from them. The Frame of this lower under Sieve is not inclosed with a Board behind, that the Wind may freely pass thro' it. The Side-boards *HF, HL*, which are seven Inches and three Quarters deep, and two Feet long, are strongly fixed to the back
Rail

VENTILATORS. 251

Rail by two square angled Iron Plates, nailed both to the Rail and Side-boards, whereby to strengthen the whole Frame. This under Sieve, when thus fixed in its Place, reaches to *H H*, about six Inches forwarder than the Back-heaver. The great Breadth of this under Sieve, for the Corn to pass over, gives thereby so much the greater Chance for the more Corn to drop through, and to leave the Chaff to be carried on farther beyond the Corn, and consequently to be blown, as the Chaff falls so much the farther from the Heap of Corn.

581. THE Advantages of having the Corn pass thro' both these Sieves at once, are very great; for it is found upon Trial that Corn may be cleaned thus much sooner and better than by the usual ways of cleansing Corn. For much the greatest Part of the Corn which falls thro' this Riddle-Sieve, is at once clear from *Chaff* and *Huzzes*; which *Huzzes*, with some Ears, are carried forward on the Surface of the Corn on the Sieve, and fall off with some of the Corn over the fore Rail *H H*, which Corn, being tailed off with the *Huzzes* and Ears, after it is cleared from them by the common Hand Riddle-Sieve, is to be
thrown

thrown up in a Heap on one Side, with some of the next less foul Tailing, in order to pass thro' the same Back-heaver again, and is then to be mixed with the other fore Part of the Corn, in order to undergo another Winnowing with a finer under Sieve, which is next to be described.

582. MR. *Woods* of *Chilgrove* in *West-Dean* Parish near *Chichester*, being present when we were cleaning Wheat with this Instrument, the following very ingenious and useful Improvement of it occurred to his Thoughts, *viz.* When Wheat has passed through the above-mentioned Winnowings, then to take away the under Sieve, and place there another like but much finer Sieve in its Room; and to have a Piece of Sackcloth fix'd near under the Sieve to receive the Seeds, very small Corn, Dust, &c. as it falls through the Sieve. This I immediately put in execution. The Mashers of this Iron Wire-Sieve were so small, as to have eight of them in the length of an Inch, the Size or Diameter of the Wire being about one 48th Part of an Inch, *viz.* a small Size less than the Wire of the first made under Sieve.

VENTILATORS. 253

583. As this under Sieve ought to be in a something more inclining Posture than the other under Sieve, so it is suspended more nearly parallel to the upper Back-heaver, the hinder Part of it being only one Inch lower from the Back-heaver than the fore Part.

584. A PIECE of Sackcloth was nailed both to the hinder Rail of the Frame, and also to the foremost Edge of the fore Rail, that the Seeds, Dust, &c. which fall through the Sieve might lay under this fore Rail: This Sackcloth was also nailed at one End to the Frame, but at the other End it was buttoned over the wooden Molds of eight Buttons, which were nailed for that purpose at *r*, that by unbuttoning of this, the Dust, Seeds, &c. might be poured out; the Sackcloth was loose to such a degree, as to bag down only about four Inches below the Sieve, so as very little to hinder the free Passage of the Wind from the circulating Fan. This Sackcloth was lined with brown Paper pasted to it with stiff Paste, which had Rosin mix'd with it to prevent Rats and Mice from eating it.

585. FINDING upon Trial, that the Corn which is thrown on the Board *Z Z*, *XX*, slid down from it too unequally, and sometimes in too thick a Quantity, this Inconvenience was effectually remedied by placing at *XX* edge-ways a long Piece of Board, which was two Inches and half broad; which made the Corn run in a thin even Spread under it; whence, passing over the Sieve in the same manner, the very small Corn, Blacks, Seeds, Mouseturds, &c, dropped through the Sieve on the Sackcloth; and what could not drop through the Sieve, such as bruised Corn, Smut-balls, &c. being, in falling in a thin Sheet, exposed to the Force of the Fan's Wind, was blown beyond the good Corn.

586. THE tailing Corn may soon be cleaned by passing thus several Times over this fine Sieve, and the best of the very small Corn which passed through the Sieve, with the Seeds, Blacks, &c. may in the same manner be separated from them, and then be mixed with other tailing Corn.

587. THIS Method not only makes much greater Dispatch, but is also better than a Wire Hand-Sieve of the same sized Mashies, because

VENTILATORS. 255

because by this means the Corn is continually passing in a thin Sheet over this Wire-Sieve, which gives Liberty to the Seeds, Blacks, &c. to drop through on the Sackcloth; whereas in a Hand-Sieve of the same degree of Fineness, the Thickness of the Mass of Corn in the Sieve prevents many of the Seeds, &c. from falling through the Sieve.

588. So that this happily proves to be an excellent Method to clean Wheat with dispatch, and effectually, from very small Corn, and also from Seeds, excepting that of Crow-Garlick, which grows in some few Fields, and ought to be weeded, as is practised by some Farmers, both in the Field, and in the Sheaf in the Barn, before it is threshed.

589. THEY who would be very curious in cleaning Corn for Seed, may do well to repeat the sifting of it through this fine Sieve, so as not to leave any Seeds in it.

590. THE like small Seeds may also be got out of Barley by this fine under Sieve. When the under Sieve had only three and half Masches in the length of an Inch, it cleaned Barley well, and with great Dispatch.

591. THE same fine Sieve, with the Sackcloth under it, may also be useful without a Fan in large Granaries, to clean Corn when it is to be moved or turned, from Seeds, Dust, &c. which Dust is observed to contribute not only to the spoiling of Corn in Granaries, but the Meal also of foul Corn will not keep so well as that of clean Corn.

592. IN order to preserve these Instruments from being spoiled, it will be well to have Shelves in proper Places in the Barn to set them on, and also to cover the Sieves with Bags of Sackcloth. The Wires *XX*, *ID*, may be covered with a Sliding-Board. These Wire-Sieves cost a Shilling a Square-Foot, which is no great Expence.

993. THE Wire-Sieve makers say, that Iron-Wire is but half the Price of Brass-Wire, and that it will last much longer.

594. WHEN Ventilators are applied to winnow Corn, either in Barns or in Corn-Mills, in order to make the Stream of Air as it rushes out the more equal, it will be adviseable to make the Valve-Box *N.M. 2.* *Fig. 3.* very large, and its Outlet or Nose *P*,
small

VENTILATORS. 257

small in proportion to the Valve-Holes: By this means, the Inconveniencies from the Inequalities of the Air's Velocity, may in a good measure be obviated, so as to make the least Velocity sufficient for the Purpose. This is the case of the left Ventricle of the Heart and its corresponding Arteries, the Ventricle answering to the Ventilators, and the Arteries to the Valve-Box *N.M.* but the Blood being an uncompressible Fluid, a very considerable Degree of its Velocity is continued in the Intervals of each Contraction of the left Ventricle of the Heart, by the Contraction of the dilated Arteries. And thus the Air, a very dilatable and compressible Fluid, being compressed in the Valve-Box *N.M.* will by its dilating Power continue to rush out at the Nose *P*, with a considerable degree of Velocity in the Intervals of the Impulses of the Midribs: which I find to hold true in the Case of my large Ventilators, *Fig. 2, 3.*

595. MR. Yeoman, the Author of many ingenious Contrivances, has one for this Purpose, *viz.* by fixing a Midriff in the Valve-Box *N.M.* *Fig. 3.* with its Hinge End just over the Valves 2 and 5, and its moveable End over the Nose *P*. And there being no Cover

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or upper Board *Q. N. I.* to the Valve-Box, this Midriff, whose Edges are lined with Sheeps Leather, supplying its Place, and rising a little when the Air rushes with greatest Velocity out of the Ventilators, and falling when the Motion of the Midribs of the Ventilators is changing; whereby the Stream of Air blows with a more uniform Velocity on the falling Corn. In his first Trial he made the Valve-Box and its regulating Midriff one-fourth of the Length of the Ventilators, and afterwards two-thirds of that Length; and proposes in the next which he makes, to have the regulating Midriff of an equal Length with the Midribs of the Ventilators. By this means, the greatest Velocity is somewhat abated. But when this cannot commodiously be done, and will make the Work too large, it may suffice to have the Valve-Box *N. M.* pretty large, and its Nose *P* of such a diminished Size, in proportion to the Valve-Holes, that there shall be a constant Stream of Air rushing out at *P*, whose least Velocity shall be sufficient to winnow Corn well.

596. In some Parts of *England*, they employ People to pick the smutty Ears out of the Corn before they thresh it. In other Places,

VENTILATORS. 259

Places, instead of threshing, they beat the Corn which has smutty Ears among it, on the Bouge of Casks turned down sideways, thereby the better to avoid the breaking of the Smut-balls. Some thresh it with good Effect on Barley Hulls. A great Dealer in Corn informs me, that a considerable Part of the Smut of smutty Corn may be cleansed away when the Corn is very dry; and Corn may be made very dry by Ventilators worked by a Water-mill; or smutty Corn may be there washed in the Stream, and thoroughly dried by Ventilators worked by the Mill. And from the Account that is given by Monsieur *de Salerne*, in the second Volume of the Memoirs of the Royal Academy of Sciences, published in 1755, of the very noxious Quality of smutty Wheat, more especially of the new Wheat, we see great Reason to use all proper Means to cleanse it of the Smut, which Wheat is observed to be most subject to in wet Years. The Illness is observed to begin soon after Harvest, and is so very malignant, that of 120 Patients ill of it in the *Hotel Dieu* at *Paris*, but four or five recovered; their Legs mortified, neither would Amputation prevent, but hasten their Death; and those who recovered, were observed not

to live long. A Hog and Ducks have been killed by eating it.

597. MR. *Yeoman* has ingeniously contrived and made what he calls a *cleansing Engine*, which consists of three Parts, the Corn passing through three different Operations at the same Time: The first is to break the Smut-balls, and clear the Smut which is apt to adhere to the soft Ends of the Wheat, by the strong Friction of a stiff round Brush, which is two Feet in diameter; whose Motion is like that of the upper Stone of a Corn-mill, and receives the Corn in the same manner through its Middle. Upon the Brush is a Stone to give Weight and Steadiness to its Rotation; it serves also as a Flier. Under the Brush he at first put a Tin Plate punched full of rough Holes like a Nutmeg or Bread-grater, but finding that it wore out soon, he makes use of the *Darby Peak* Mill-stone. While the Corn is passing between the Brush and the Stone, the Smut-balls are broke, and the black stinking Smut which adheres to the soft Ends of the Corn, is thereby in a good measure rubbed off. Hence the brushed Corn falls on a flat broad Wire-Screen, which lies gently inclining. This Screen is jogged or shaken

VENTILATORS. 261

shaken lengthways by a short Crank or Crook in the lower Spindle, which turns the Brush round, whereby the Corn is spread thin all over the Skreen, and whereby it is cleared of the thin Corn, the Dust and Seeds. The Corn is exposed to a Blast of Wind from a small Ventilator as it falls in a thin Sheet from the Skreen. The small Ventilator is worked by a Crank or Crook in the Axletree of the Cog-wheel, which upright Cog-wheel moves another horizontal Cog-wheel, whose Axletree as it turns, gives Motion to the Brush and Skreen. The last cleansing Engine which he made of this Kind, had another Ventilator to blow the Wheat as it falls in a Sheet from a Granary into the Hopper which is fixed over the Brush; by which means the Wheat is cleared of a great many of the Smut-balls, Dust, and other light Matter.

598. THE first cleansing Engine which he made is turned by Hand with a Winch, with which a Man can easily dress two Quarters of Wheat in an Hour; The second is turned by a Water-Wheel, and will dress four or five Quarters in an Hour: Another of these Hand-mills will dress twenty Bushels of Wheat in an Hour, after it is winnowed. It is found that

no Method yet made use of by Farmers or Millers, comes up to this for dressing of Wheat; but yet it does not do all that he would have it do; for when Corn is very much black'd at the soft Ends, it will not all brush off, though it brightens it very much, and breaks most of the Smut-balls. He was at first apprehensive that the Brush would soon wear out, but an hundred Quarters a Week were dressed with it for two Years before it was worn out.

599. WHEN Weevels are once got into Corn, it is not easy to destroy them. I have formerly, in a short Treatise on that Subject, proposed some Methods to destroy Weevels in Corn, by causing the Fumes of burning Brimstone to ascend up through it of itself; which Method General *Oglethorpe* told me he had tried with Success in *Georgia*; and may probably do in small Quantities of Corn. But having, since my Publication of that Method, made some Trials to convey the Fumes of burning Brimstone up thro' Corn in much greater Quantities by means of Ventilators, which I find does much better than when they ascend only of themselves; yet I find that even by Ventilation, in the case of great
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VENTILATORS. 263

Quantities of Corn, it will require long and much Fumigation. For though the Fumes of the burning Brimstone ascend plentifully up through Corn which lay on a false Bottom of Haircloth when conveyed by Ventilators, yet the Coldness of the Corn, and the damp Vapours which the warm ascending Fumes raise, very much abate their Acrimony, so as to make them less suffocating, and less destructive of Animal Life: which I found by Experience, by fuming thus a large Quantity of Oats which lay a Yard deep in a Bin of forty square Feet, at the Right Hon. the Lord *Feverſham's*, at *Barford* in *Wiltſhire*. For tho' the Fumes, as they ascended up through the Corn, were so suffocating that a Man could not bear to breathe in them, yet neither a Sparrow, a Mouse, Ants nor Earwigs tied up in Canvas, were killed, not in about an Hour's Fumigation. But in this Experiment, the Length of the Space which the Fumes passed through the Ventilators and Trunks, was about twenty Feet, and the Trunks were too small. This Fumigation was made with Ventilators a Size larger than those described in *Fig. 6*, the Fume being drawn into the Ventilators from a square wooden Tunnel or Hopper, which was placed inverted over the

burning Brimstone. The Brimstone will burn the more freely if Charcoal be burnt with it, or a red-hot Iron be put into it. But though these Creatures were not killed in an Hour's Fumigation, yet since Bugs are dried to Powder in two Hours Fumigation of large Rooms, perhaps large Fumigations may have the like Effect on Weevels in Corn, especially if the Corn be dry, and covered with Cloths.

600. I FOUND this way of Fumigation very effectual when I fumed a less Quantity of weevelly Malt, which lay ten Inches deep in a Box which was seven Inches wide each way. The Fumes of the burning Brimstone were blown upwards through it by a Pair of common Kitchen Bellows, whose sucking Valve was placed over a large Hole cut in the Bottom of an inverted Oil-Jar, at the Distance of thirty Inches above the burning Brimstone. A Sparrow and Bee which were placed on the Malt, and covered with coarse Cloth, were dead in three Minutes, and several other Insects in fifteen Minutes. On examining the Malt, the Weevels were all dead; even those which lay hidden in the midst of the Grains. No Weevels were seen ascending to the upper Part of the Malt during the Fumigation, which

VENTILATORS. 265

I am told they will do when the lower Part of the Corn in Ships grows too hot for them to continue in it. The Temperature of the open Air was twenty Degrees above the freezing Point: and the Heat of the Fumes among the Malt, at the End of fifteen Minutes, was forty-eight Degrees, which is three-fourths of the Heat of Blood.

601. VARRO *de Re Rustica* says, that Pelitory of the Wall mixed with weevelly Corn, drives them away; and I am informed, that both in *England* and *Ireland* it has been tried with Success.— Dwarf Elder and Garlick are said to drive Insects from Corn, by rubbing the Walls, &c. with it. *Spectacle of Nature*, Vol. 2. p. 212.

602, I SOWED in my Garden in *November*, at six Inches distance, ninety-six Grains of the smallest and poorest Wheat that I could pick out; and at the same Time sowed the like Number of fair Grains of Wheat, which I bruised with a Hammer: only three Grains of the bruised Corn grew, whence came eighty-seven Ears, several of them very large; but the Grains of the best Ears were very small and shriveled,

603. As to the ninety-six small Grains of Wheat, only fifteen of them grew, they bore 308 Ears, one had twenty-seven Ears; many of these Ears were six Inches long. The Grains of the best and fairest Ears were small and withered, but the Grains of many of the Ears were exceeding small and shriveled, so as scarce to have any Form of Grains; and in many of the Ears there were no Grains.

604. THE Year following I sowed 200 Grains of good Wheat on the same Spot of Ground; the Ears were large, and the Corn fair and of a good Size.

605. HENCE we may reasonably infer that the fairer and better the Corn is that is sown, the greater Probability there is of a good Crop of fair Corn: and at the same Time we see how unadviseable it is to sow poor small Corn, which is practised by some Farmers, for two Reasons, *viz.* because such Corn will not sell for so good a Price as fairer Corn, and because there are the more Grains in a Bushel of such small Corn, and consequently it will sow the more Ground. On the other hand, it is probable that the fairest Corn when sown, will be less subject to Blight and Smut, and
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VENTILATORS. 267

better able to endure inclement Seasons ; by throwing Seed-Corn into Water, the bad, which floats on the Surface of the Water, may easily be skimmed off and separated from the Wood.

606. IN order the more fully and clearly to know which is the best Practice, both Kinds of Corn should at the same Time be sown separately in the same Field.

607. MONS. *du Hamel de Monceau*, who translated and abridged *Jethro Tull's Book of Husbandry*, by cultivating Wheat in that Method in the vacant Places of Vineyards, had in three Years one-third greater Increase than in the common Methods of Husbandry. The Rev. Mr. *Hollier* of *Carshalton, Surrey*, in the Year 1720, had from one Barley-corn planted in his Garden, 154 Ears, which contained 3300 and odd Grains of Corn, which being planted in a Field three Inches asunder, produced half a Bushel and half a Peck of Corn, which being planted in the same manner the third Year, produced forty-five Bushels and a Peck. And Mons. *du Hamel* mentions the like Increase from a Grain of Corn in *France*.

608. IN order to try how soon and how effectually raw Gunpowder might be dried, by blowing hot Air upwards through it, I provided a Box which was a Foot square, with a false Bottom of such close wove Canvas, as the Powder-makers use to sift the Dust from their Powder; which Canvas was supported with a Lacing of Packthread, which was also supported with three Sticks, at equal Distances, which Sticks rested on little Pillars. *July 30*, a dry Air, eight Pounds of raw undried Gunpowder were put into this Box; under the false Bottom of which was fixed at the Hole in the Side of the Box, the upper Part of a Worm-pipe of a distilling Worm-Tub, which was filled with twenty-two Gallons of boiling hot Water. To the lower End of the Worm-pipe was fixed the Nose of a common Pair of Kitchen Bellows, whose lower Handle was strapped down with a Piece of Leather to the Board on which the Blower sat, by which means the Bellows were worked with great Ease. The Heat of the Air which came through the Worm-pipe, was 150 Degrees, 212 of which is the Heat of boiling Water; so that it was very near three-fourths of the Heat of boiling Water. And having placed a mercurial Thermometer
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VENTILATORS. 269

in the Powder, I could observe how the Heat increased still more and more as it dried; so that at the End of two Hours the Heat was increased to 120 Degrees; when it was dried to such a degree, as to be full Proof as to Strength; as appeared by Trial with the Proof Instrument.

609. I DRIED thus a great Variety of Flowers, with hot Air drove through the spiral Pipe of a Worm-Tub, up through a Box of Sand in which the Flowers were placed, so as to be dried with their natural Form; many of which retained their Colours well for some Weeks and Months: But at last they faded, and lost their Colour, some sooner, some later; which some of them might probably have retained longer, if Means had been used to keep them from Air by Gum Arabick, &c.

610. IN the same manner fifty Pounds of raw Gunpowder were dried at Mr. *Norman's* Powder-Mills at *East-Moulsey*, Aug. 21, the Air being then dry, cool and cloudy, the Wind S. W. the Powder was put into a Box a Yard square, with a like false Bottom of Canvas on which it lay about two Inches deep.

deep. The Box being placed near one End of the Powder-drying Stove, hot Air was conveyed thence through large Trunks, by the working of the small Ventilator, *Fig. 6.* The Heat of the Air just before it came to the Powder, was 142 Degrees. After two Hours and ten Minutes Ventilation, the Heat of the Powder was 137 Degrees, when it was completely dried; so as to be by the Proof Instrument of the same Standard of Strength with some of the same Powder dried in the Stove in the usual way: and it was observable that the Waste in drying was the same. Hence we see that great Quantities of Powder might thus be dried with much Safety and less Expence, especially if the drying House was so near a Stream as to have the Ventilators worked by a small Water-Wheel; which would save the Expence of Labour in working them: or they might be worked by the Labour of the same Horse that grinds the Brimstone or Charcoal.

611. FROM the Event of the Experiment in drying eight Pounds of Gunpowder in two Hours, by means of hot Air being drove thro' the Pipe of a distilling Worm-Tub, it may reasonably be concluded that the damp Gunpowder

VENTILATORS. 271

powder in Ships will be much more expeditiously and effectually dried thus, than by the present Method of drying it in broad Pans heated with hot Water under them; because in this ventilating Way a Succession of hot ascending Air incessantly surrounds and passes by each single Grain of Powder, and thereby carries off the Moisture: whereas in the Method with heated Pans, there can be no such Stream of hot Air to warm at the same Time the upper as well as the lower Part of the Powder; which may therefore be layed the thicker in the ventilating Way, and yet be sooner dried. The Powder-makers say, that as the common Degree of Dampness of Ship Powder is not near so great as that of raw undried Powder, so it will dry in much less Time: They also say, that if Ship Powder is as damp as raw Powder, no degree of drying can make it good without being first made up.

612. Now in order to apply this Experiment to the drying of damp Powder in Ships, it is proposed to have a Box with a false Bottom of Canvas about a Yard square, on which fifty Pounds of Powder will lay about two Inches deep. And whereas the spiral Worm-pipe

pipe abovementioned, was about ten Feet long, and the Diameter of its Bore but half an Inch; it is proposed to have it an Inch or Inch and half diameter, and the spiral Worm-pipe to be considerably longer, that the Air may be the more heated, by passing through so great a Length of so large a Pipe. It is proposed also to have the Bellows large, or rather to use very small Ventilators, about two Feet wide. A Trial of this Kind may be first made on Land, with little Expence.

613. WE have hence also a Hint for drying several Kinds of Things, as Corn, &c. without communicating to them any Fume of Fire, *viz.* by conveying plenty of hot dry Air among them, by means of a large Worm-pipe fixed in a large Caldron, where a small Fire would keep the Water in a constant scalding Heat; its Waste by Evaporation to be supplied by a constant small Stream, and the Quantity of its Wasting to be much checked by a close Cover; the hot Air to be impelled through the Worm-pipe by Ventilators of a proper Size.

614. I AM informed, that in the *East-Indies* they expose the Saltpetre to drying open

VENTILATORS. 273

open Air and Winds, in order to make the Powder the stronger. And if Saltpetre thus dried, will make the stronger Powder, notwithstanding it must be wetted too, in order to make Powder; is it not hence probable, that Powder dried only with a very dry Air, will be stronger than Stove-dried Powder; where it is also in danger of being damaged by over-heating? And might not a great Quantity of Powder laid of a considerable Depth in a false Bottom on Canvas, be soon dried in a hot Climate, in the middle of dry Days, by blowing Air upwards through it with small Ventilators?

615. HAVING thus dried damp Gunpowder by blowing the common dry Air upwards through it, it led me to propose many Years since in my Ventilator-book, the preserving Powder in the Powder-room of Ships dry, and consequently good, by blowing fresh Air into the Powder-room for about a quarter or half an Hour in the middle of dry Days, two or three Days in a Week, with the small Ventilators, *Fig. 6.* For if fresh dry Air will dry damp Powder, it is reasonable to believe it will keep dry Powder dry. The Hon. Count *Bentinck* informed me, that he had

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known Powder keep perfectly good for above a hundred Years by being preserved dry. And having been since frequently informed, both by several Commanders of Men of War, and by the Makers of Powder for the Government, that the Powder in Ships is apt to spoil, occasioned by the damp putrid Air of Ships, which soaks not only into Cartridges, but also thro' the Substance of the Wood of the Barrels; which Inconvenience may be prevented by blowing fresh dry Air into the Powder-room as long and as often as Experience shall prove it to be necessary: which may be known either by weighing a Cartridge, or by an Hygrometer properly fixed, so as to shew with great Accuracy by a Hand turning in a Circle, which Hand may turn on a small Wire passing through one Side of the Powder-room. But the small Ventilator must be supplied with fresh Air either by a Trunk leading to a Port-hole, or by some other Means that shall be thought best. And in order to change the whole Air of the Powder-room, it will be requisite to have it blown in at one End, and out at the other End; and where it is blown out, there must be a Valve to cover the Hole, so as to open for the Air to pass out, but to fall to immediately of itself,

self, thereby to prevent the Entrance of the damp putrid Air of the Ship: And when the Ventilation is over, the two Holes, which need be but four Inches wide, may be stopped as effectually, and with as great Security as if there had been no Holes.

616. POWDER in large Magazines, may be something the better preserved by having several Hygrometers in them: and one Hygrometer exposed to the outer Air, yet so as not to have Rain fall on it. This is to be for a Standard, thereby not only to know when are the proper Days and Times of Day to admit the external Air into the Magazine, but also to know the comparative Driness of the Magazine at all Times, with the driest external Air.—The Shutters and Doors ought to be made as Air-tight as possible. Whenever the Floors are wetted, in order for the Mens working with Safety, I believe it will be better to admit a free thorough Passage of the external Air, with a greater Degree of Dampness than one would otherwise chuse, when the Floors are dry: But in what degree of Dampness the external Air may be admitted, will be best determined by the Hygrometers. But supposing the Air of the Ma-

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gazine to be very damp with a wet Floor, then it is certainly better to have an equally damp fresh external Air pass through the Magazines than not; because a confined damp Air is constantly tending to a State of Putrefaction, that most subtile Dissolvent in Nature; and will therefore in that State be more apt to penetrate through the Wood of Barrels. This, as I guess, is often the Case of Powder-rooms in Ships. But when Magazines are under Ground, or so constructed and conditioned that the external Air cannot at proper Times be admitted to pass freely through; in these Cases the blowing Air in with Ventilators, through long Trunks reaching to the farther End, opposite to where the Air goes out, would probably be of service.— As to the Benefit which is found by turning the Barrels, I guess the Reason of it is to prevent its caking, by thereby changing the Points of Contact of each Grain; and if so, then the moister it is, the oftener it should be turned.

617. WOULD it not be well to lay a thick Coat of Paint on each Barrel when the Wood is well seasoned? For as Paint is well known to keep the sappy Damp of Wood from evaporating, so doubtless it will considerably contribute

VENTILATORS. 277

tribute to hinder the soaking in of the Damp from a damp Air. The ingenious Dr. *Lewis* of *Kingston*, found that Moisture would not soak into a Fir Board, which was painted with Litharge and Oil boiled. A great Variety of Paints, &c. might easily be tried, which would doubtless lead to the better preserving Powder in Barrels. The Wood should be first well soaked with Oil before it is painted, else the Wood, by sucking away the Oil of the Paint, will leave it a mere useless dry Powder.

618. VENTILATORS might probably be of service in making Salt, as was long since hinted to me by the excellent Dr. *Wilson*, late Bishop of *Sodor and Man*; but then, in order to this, it will be necessary to have the Convenience of the Stream of Water to work the Ventilators; and the Brine must be in long narrow Canals, covered with Boards or Canvas, about a Foot or less above the Surface of the Brine, in order thereby to confine the Stream of Air so as to make it act upon the Surface of the Brine, to carry off the the Water in Vapours; for as falling Water carries down Air with it, so does moving Air carry with it some of the Water with

which it is in Contact. Hence it is that Rain not only moistens the Earth, but also brings down Air mixed with it, as well as other nutritive Materials, to make it the more fruitful: And for the same reason it is probable, that River-weeds are observed to thrive and grow best after Showers of Rain. Hence we see how reasonable the Practice is to water Plants with a Shower through the Rose of a Watering-pot, in imitation of Nature.

618. AND not only the Expence of Fuel might by this means be saved by thus evaporating the Moisture away to a strong Brine, but it may by the same means be reduced also to a dry Salt in Winter and Summer, both in a rainy and dry State of the Air, the Salt being thin spread. For I found that a Linen-cloth which was hung under a Shed, open on all Sides, which was very wet, with eight Ounces and half of Water in it, had seven Ounces and three Quarters dried away in eighteen Hours in Winter; during the greatest Part of which Time it rained, there being a strong Wind. And large Ventilators worked by a constant Current of Water, would blow a constant Stream of Air over the Surface of the Salt-water in a long Canal. For since
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Bay-salt can thus be made in Brine-ponds and Pits on the Coast of England, without Fire, notwithstanding we have much moist Air, and but a small Proportion of Sun-shine; Salt will doubtless be dried by a constant Stream of Air, which is well known to dry more than Sun-shine, because Air and Water mutually attract each other; and if this can be effected, then the Salt thus made will be much the better for it, not only on account of having little of its fine acid Spirit evaporated away, as is done by the great Heat of Fire, especially at the latter Part of the Operation, but also, as is observed by Dr. *Brownrigg*, in his ingenious Treatise on *The Art of making Salt*, p. 250. “ That as Sea-salt prepared by the Heat of the Sun is more free
 “ from *Scratch*, which is white calcarious
 “ Earth, and also from Bittern than most
 “ Kinds of white Salt; it is more proper for
 “ preserving Flesh and other Kinds of Provi-
 “ sions. For the Marine Bay-salt is not ex-
 “ tracted in a hasty tumultuary Way, but by
 “ a slow and gentle Heat; so that when a
 “ certain Portion of the Water has exhaled,
 “ the calcarious Earth separates from it, and
 “ subsides in the Brine-ponds, being depo-
 “ sited before the Brine enters the Salt-pits,

“ where the saline Particles concrete together ;
“ and after they have united into pretty large
“ Crystals, are drawn out pretty free from
“ the Salts of the Bittern, which remain dissolved in their watry Vehicle.”

620. By this means, white Salt may be made with little Expence, and without carrying off much of its Virtue, the Spirit of Salt, by the great Heat of Fire, and also from much of the Dirtiness of Bay-salt, especially if they give the Brine a Boil, just only sufficient to clarify it with White of Eggs.

621. As the Ventilators would be worked by a Stream of Water, they might be very large, and have several of them laid one on the other ; and where Water cannot be had, they might be worked by a Wind-mill ; by which lesser Quantities of Brine would be made, as it would stand still about one-fourth of a Year for want of Wind : whereby great Quantities of Air might be conveyed with great Velocity, so as to be sufficient to ventilate at once two or three long Canals. For it would be requisite to draw off the first Brine into another Canal as soon as the *Scratch* is subsided to the Bottom, and also into a third Canal,

VENTILATORS. 281

Canal, to dry the Salt when separated from the Bittern.

622. VENTILATORS might also be of use to those who wash large Quantities of Linen in great Towns, if the Linen were hung in low, long, narrow Galleries, especially in damp rainy Weather; which would not only dry the Linen whiter than by Fires, but would also prevent the Danger of firing Houses, which has often been occasioned by the large Fires they have to dry Linen.

623. THEY would also probably be of use in drying in the same manner woollen Cloths after they are fulled or dyed; and the Ventilators might be worked by the fulling Water-mill.

624. SUCH whole Pieces of woollen or linen Cloths might also probably be well dried, being hung about six Inches distant in long, narrow Galleries, which supposing they were situated lengthways East and West, then when the Wind was North, to have a Door at one End with Hinges, on the South-side: this Door to be opened at an Angle of forty-five Degrees, more or less, according to the different

ferent Points the Wind is at : and at the other End of the Gallery, the Door to be fixed with its Hinges, on the North-side : this Door also to stand open at a proper Angle. By this means the Air which is drove in at the other End, will be drawn out at this End ; as I have found by Experience, by laying on a Wall a Trunk thus prepared, which was six Feet long and two Inches wide within, when the Flame of a Candle held at the proper End, was forcibly blown on by the Air which came through the Trunk. And when the Wind is in the South, the contrary Doors of the Gallery must be opened in the same manner ; and when the Wind is easterly or westerly, then both Doors at each End must be opened to proper Degrees, so as to form Tunnels to conduct the Wind in at one End, and promote its passing the more freely out at the other End. By this means the Wind in all Points will pass through the Gallery, and will consequently dry the Cloths. The same Method would also be useful to those who wash great Quantities of Linen.

625. As to Malt or Hop-kilns, I believe it would be best to have the Air-trunk enter the Kiln about eighteen or twenty-four Inches from
from

VENTILATORS. 283

from the Ground, and just opposite to the Fire: But in order to prevent the Air's blowing too strongly on the Fire, I believe it would be well to have a Skreen of Brick-work about a Yard distant from the Hole of the Air-trunk, a Yard high and a Yard long; the Bricks may be laid without Mortar, especially at a first Trial, with their Ends about two Inches distant from each other. By this means the Air from the Ventilators would be the better diffused through the whole Kiln: Experience will best rectify these things. As the Indraft of Air at the Fire-place, will be lessened while the Ventilators work, so it is probable there will be need of more Fuel to keep a something larger Fire, which may be done when Ventilation is used, without danger of making the Malt too brown; because when the Quantity of warm Air which ascends thro' the Malt, is much increased, the Moisture will be carried off so much the faster, and thereby prevent its being stewed too much in its own Wreak.

626. I PUBLISHED in the Year 1739, a Proposal for salting Animals whole, by injecting warm Brine into the Arteries by the Force of a perpendicular Height of that Liquor thro'

a hollow Cane about eight or nine Feet high, for Oxen, and half that Height for Sheep, Hogs, &c. which Force is nearly equal to the Force with which the Heart impels the Blood through the Arteries. This I thought a probable Means to make Flesh immediately take salt when it had salt Brine in it, to melt it; whereas in hot Climates Flesh putrefies soon, before the Salt has time to enter far into it.

627. THE Efficacy of this Method is now fully proved by Experience: For having furnished my Parishioner Mr. *Macferison*, then Purser to the Hon. Admiral *Boscawen*, in his Expedition to the *East-Indies*, with a brass Cock proper to fasten to the great descending Artery on the left Side of the Back-bone, at the Small of the Back, he made the Trial at *Madagascar*, on four Oxen, in the Mid-day Heat, by injecting Brine thus for five or six Minutes only; for it immediately flows to the extremeſt Parts, and pervades all the Flesh to ſuch a degree as to make it readily take ſalt, when cut in proper Pieces to be ſalted and barrell'd. This they fed upon for two Months in their Voyage home, till it was all eaten; it continued good to the laſt. This Method of preſerving Fleſh in hot Climates,

VENTILATORS. 285

mates, will therefore doubtless be of service, especially to Seafarers.

628. WHEREAS Flesh soon putrefies in hot Climates before its inner Substance can get cool and take salt; this Inconvenience may probably be in a good measure prevented by suspending an Animal (as soon as it is flead, and its Inwards taken out, and its Breast laid open and spread flat) in a Well or other cool Place under Ground; the deeper the better: and then blowing fresh Air frequently, *viz.* every half Hour, from a Ventilator above Ground, through a Trunk of four or five Inches wide within, and reaching down to the lower Part of the Animal; under which must be suspended by Cords, an open wooden Vessel to receive the Blood, &c. that may drop from the Animal, which if it dropped to the Bottom of the Well, would make it so putrid a Place, as would hasten instead of retard the Putrefaction of Flesh. This Vessel must therefore at proper Times be drawn up and cleansed. The Ventilator may be of the same Make with the single one, *Fig. 6.* but a Size larger.

629. AND if a Coule, *viz.* such as are on Malt-houses, were fixed to the Top of the Trunk

Trunk a Foot wide, which goes down into the Well, with its Fane so placed behind it, at to cause its open Part always to face the Wind; this would convey down a continual Stream of fresh Air whenever the Wind blew; so that the Ventilators need only be used in calm Weather. In our Sugar Islands the Wind constantly blows either to or from Land. By this means the Flesh will not only be in a cooler State, but the damp foul Vapour from the Animal, which would soon putrefy, will be incessantly carried off before it can have time to putrefy: And thus Flesh both raw and dressed, might be kept much longer sweet, and also free from being blown with Flies Eggs. The Degrees of Coolness of such a Well at different Depths, may easily be known by letting down a Thermometer.

630. I AM credibly informed, that in *Lapland*, *Muscovy*, and other cold Countries, they prevent the ill Effects that Freezing would have on Fish, Flesh, Fruit and Wine, by immersing them for some Time in very cold Water, where they will be surrounded by a Crust of Ice, occasioned by their frozen State; which Ice being broken off, the Fish, &c. will be good to eat.

VENTILATORS. 287

631. NUMB. 234. Vol. I. a Propofal is made to try whether a Sheathing of Fir-boards soaked in vegetable Oil, might not be very ferviceable and durable; but Animal Oil, fuch as that of Fifhes, will not pre-ferve Wood. Since which I laid four large Pieces of Fir-boards to soak in Rape-feed Oil for fix Months, two of which were of white, and the other of red Fir; the Oil soaked but about one-tenth of an Inch into the white Fir, but quite through the whole Subftance of the red Fir, though it was three quarters of an Inch thick. And the fame is obferved in painting of Wainfcot, the Oil not soaking near fo much into white Fir, which has had its Turpentine-fap drawn off, as into red or yellow Fir or Deal, which is full of Turpentine; and therefore it is cheaper to paint the white than the yellow Deal Wainfcot. Oak muft firft be well oiled, or elfe the Colour will be feparated from the Wood. This Difference might plainly be perceived both by the Smell, as alfo by the ouzing out of Plenty of Oil before the Flame of fmall Chips of the red Fir; but on burning thus the white Fir, the Oil ouzed out only near its Outfides. Whether any thing difagreeable to the Tafte of thefe Worms can be made to penetrate

with the Oil into the Substance of red Fir, must be left to farther Researches. As the thus soaking Fir in Oil will give the Boards a great degree of Toughness and Durableness, it may be of considerable Service to use such oiled Boards, (at least in the Line of the Surface of the Water) round Ships, and on their Bowes, where they are most subject to decay, or to be torn off: But to soak in Oil thus for the whole Sheathing of a Ship, might be too expensive; besides that it may be doubtful whether the Dressing or Graving will cleave fast to such oiled Boards.

632. It would probably be a good Means to preserve Timber Fabricks, (especially such curious and expensive Fabricks as that of the Bridge at *Walton on Thames*) much the longer from decaying, to cover them with Weather-Boards so fixed as to leave sufficient Spaces for the Air to pass up freely between them; for wherever the Air can come to dry off the Damp or Wet before it has time to soak deep, there the Timber will last long, as is evident in the Case of the outside Timber of very old Timber Houses; but when the Wet continues so long as to have time to soak in deep, and is alternately dried off and wetted, it

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thereby

VENTILATORS. 289

thereby loosens and carries off the Substance of the Timber. This may be observed in Piles, which are alternately sometimes for a considerable Time under Water, and sometimes not.

633. IN the Preface of *Monf. Demours's* Translation of my Treatise on Ventilators, I find the following Receipt for careening and dressing of Ships, to preserve them from Worms; which was communicated to the Translator by a Merchant of *Marseilles*, who affirms he never knew it fail of Success. *Viz.*

634. TAKE a hundred Pounds Weight of the finest Pitch, melt it over a slow and steady Fire of Coal; when it is thoroughly melted, add to it thirty Pounds of roll Brimstone grossly bruised, and boil the whole over a Coal-fire till thirty Pounds are wasted. It is nearly boiled enough, when it adheres to a Stick dipped into it, and will not run off. For greater Exactness the Pot must be left to cool, and then weighed, to ascertain the Diminution of thirty Pounds, till Experience shall teach to know when it is boiled enough without weighing; the Scum must be continually taken off, as in boiling of Sugar, lest

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it should rise above the Brim of the Pot; but if its rising up cannot by this means be prevented, it may be quelled by throwing in a Lump of Fat, and diminishing the Fire. The Matter, thus prepared, must be kept in Casks in a dry Place, because it is very subject to be spoiled by Moisture.

635. WHEN it is to be used, melt a-new the Quantity of a hundred Pounds, and when it is become pretty liquid, add thereto by little and little, thirty-five Pounds of Brick-dust, or Marble-dust sifted, and well heated to take off its Moisture. These Ingredients are to be continually stirred with a Stick, that they may be thoroughly incorporated: and in this second Operation, Wood will serve instead of Coal-fuel.

636. WHEN this Composition is used, it must be very hot, and the Boards dry. In the case of old Ships the Surface of the Boards must be burnt, and well scraped to get off the old Paying, that the new Composition may adhere the better.

637. SOMETIMES the Pitch happens to be too gross and thick, and sometimes it is too liquid:

VENTILATORS. 291

liquid : In the first Case, the Quantity of the Brimstone must be somewhat lessened ; and in the other, the Quantity of the Brick-dust somewhat increased : but Experience will best shew what is to be done in either Case. The Brick-dust hardens and petrefies the Composition, and renders it impenetrable by Worms.

638. THIS Composition will perhaps to the Knowing in these Matters, not appear so much different from those in common Use, as to be regarded. The Pitch and Brimstone are the ordinary Ingredients in these Kinds of Compositions, to which every one adds what he thinks fittest for his Purpose : But this can be no Reason why this Receipt should be rejected, since a small Difference often produces great Alterations. This Composition then may be boldly substituted instead of the common Sorts, since it is as good as any of them, and has moreover the Advantage of being tried more than once with Success.

639. THE Person to whom I am obliged for this Receipt, had so great a Confidence in it, that he used it on the Planks of the Ship without sheathing, (the Charge of which is considerable, besides the Inconvenience of

making the Ship fail the heavier) and the Success never failed his Expectation. A Trial might first be made upon the Sheathing of Vessels bound for long Voyages.

640. IT must be here observed, that after a long Voyage, and before a Ship takes in a fresh Lading, you are to make a Search, and repair the Dressing in all Places where it is wanting. The Merchant assured me, that it never came off from the Part of the Vessel under Water. But as the Line of the Water in a long Voyage, sinks more or less sometimes a Foot, in proportion to the daily lightening of the Vessel, some Parcels of it may possibly come off from that Part which rises insensibly above the Water, and is exposed to the Rubbing of the Long-boat, which it may be proper to repair before the Ship puts again to Sea.

641. MR. *Henry Bird*, an ingenious and skilful Ship-builder at *Rotherbith*, to whom I sent this Receipt, says that it is a sufficient Fence, being a Sort of Terras: The only Objection besides the Expence, is its being liable to break or peel off; this hard Sort of Graving is more apt to do so than the more malleable;

VENTILATORS. 293

malleable : the Cables sometimes rub against the Ship's Bows under Water ; and other Accidents may make some Parts bare, and so endanger the whole. He has little Hopes that any Composition will be found fully to answer the Purpose, because the Planks soaking so long in Water, are so filled therewith that at length the Moisture between the Graving and the Planks throws it off, and in time will take place of all that the Planks can be tinged with.

642. SALT-WATER will prey upon Pitch, but when mixed with Brimstone it becomes more serviceable. Turpentine and Brimstone is the best Composition he has met with, and comes home from a Voyage with least Damage from Water or the Soil. The Method of doing *East-India* Ships, is by first sheathing, and then filling that Sheathing with small broad-headed Nails, which is about double the Expence of common Sheathing ; it is a safe and sure Fence from the Worms, and becomes in a little Time one continued Cake of Rust, and is not liable to be damaged by Cables or common Accidents. Sheathing is of great service in preserving a Ship safe and

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tight, if there were no Worms in the Sea, and is therefore good in long Voyages.

643. A PERSON who has been much in the *East-Indies*, informs me that they have there an effectual way to prevent the Worms destroying their Ships, *viz.* by paying them first with a Mixture of Mustard-oil, (which abounds there) and Lime of Shells, and Hogs Blood: Rape-feed-oil which is cheap, will probably do as well. They then sheath the Ship; the Sheathing must be renewed after some Years. He says Ships have been thus preserved for a great Number of Years.

644. IN the *Spectacle of Nature*, Vol. III, p. 130. there is Mention of a Paying for Ships to prevent the Worms, made of Pitch, Train-oil, Tallow and Glafs, which must be often repeated.

645. The *Indians* make use of the droffy Part of Aloes to besmear the Bottom of their Ships, *viz.* because this Part of Aloes will not dissolve in Water, p. 58. of the Method of preserving Drugs. And might not this do well to prevent the Worm?

VENTILATORS. 295

646. I AM informed that the *Muscovites* prevent the Worms from eating Planks by soaking deep, Oil, or Spirit of Vitriol, and Copperas, while the Planks are wetted and warm for bending.

647. As Verdigrease is most noxious to all Animals, it might be well to mix it with the Paying of Ships: Or if Copper-filings were mixed with the Paying, Sea-water would turn them into Verdigrease.

648. It might be well also to lay Planks to soak in Water, strongly impregnated with Verdigrease, for if it can be made to soak some Depth into the Planks, it would be an effectual Means to preserve them from the Worms.

649. MR. *Andrew Reid*, in his Book on the Acid of Tar, is for the Trial of the acid Juice of Tar, prepared either with Copperas or Oker, to preserve Ships either from Rotting or Worm-eating; as the *Finlanders* preserve their Timber-Houses from decaying 100 and 150 Years, by painting them with Acid of Tar mixed with pulverized Oker, which Acid is everywhere thrown away. If, as

Dr. *Lewis* of *Kingston* informs me, Oil and Litharge will prevent Moisture from soaking into Fir, then this might be a good Preservative of Fir-board Sheathing from decaying.

650. THE following is an approved Method to preserve the Boards and Timber of Out-door Work, *viz.* Melt six Pounds of Pitch, add by sifting one Pound of dried *brown Spanish* or Whiting, and a Quart of Linseed-oil.

651. SOME have proposed to prevent the Worms eating Ship-planks, by washing them often with a Decoction of Arsenick, which will destroy Bugs; and it is thought that cold Sea-water will not dissolve the Arsenick, tho' hot Water will. But it is to be feared that when a Ship is broomed or breamed with Fire to burn off the Filth, that Heat may raise noxious arsenical Vapours. Mr. *Reid* informs me, that in *China* they divide their Ships into several Water-tight Partitions, so that the Ship will not sink if there be a Leakage in one Partition.

652. As Fires frequently happen by the boiling over of Pitch or Tar, the following
Method

VENTILATORS. 297

Method for preventing the same having by repeated Experiments been found effectual, is recommended to the Publick in the printed Proposals of the *London Insurance-office*.

653. AT the Bottom of the Vessel, wherein Pitch or Tar is to be boiled, put some soft Birdlime; then let the Vessel be heated gradually, that the Birdlime may be dissolved before the Pitch or Tar boils; which may be known by the rising of small yellow Bubbles round the Sides of the Boiler; and when they appear, the Liquor will not be apt to boil over.

654. THE Vessel must not be filled, but some Room left for Boiling; and in large Vessels, wherein twenty or thirty Gallons are to be boiled, the Depth of six or seven Inches should be left unfilled; it must be kept stirring while it is heating, until the forementioned Bubbles arise.

655. CARE must be taken, that nothing cold be thrown into it while it is boiling; so that if Brimstone is to be mixed with it, or any Pitch or Tar is to be added, the Fire must first be damped or taken away; and
when

when the Liquor ceases to boil, then put in Birdlime proportionable to the Quantity of Pitch or Tar to be added, and taking the Precautions aforesaid for Boiling.

656. FOR a Barrel of clean Tar, (from thirty-two to thirty-six Gallons) or for a Barrel of good Pitch, (about two Cent. and half) four or five Ounces will be sufficient; but if the Pitch is foul or soft, six Ounces must be put in at a Medium,

one Ounce to $\left\{ \begin{array}{l} 7 \text{ or } 8 \text{ Galls. of Tar,} \\ \frac{1}{2} \text{ C. of Pitch.} \end{array} \right.$

657. PERHAPS some other cheaper clammy vegetable Substances may have the like good Effect if made of Barley, Rye, or Wheatmeal; at least it may be well to try the Thing in little in a Pipkin.

*A Proposal for checking in some degree,
the Progreſs of Fires.*

658. **T**HE LATE destructive Fire in Cornhill, London, bringing to my Mind what I had long ſince thought a probable Means to check, in ſome degree, the ſpeedy Progreſs of Fires; which if it could be effected, would be of great Importance; I made the following Experiment in order to form ſome Judgment of the matter, viz. I placed on two Garden-pots a dry Fir-board, which was half an Inch thick and nine Inches broad; and covered nine Inches length and breadth of it with an Inch depth of common damp Garden-earth, fencing this Earth on each Side with two Courſe of Bricks, in order to make a Fire-place to contain the Wood Fuel and live Coals, frequently blowing with Bellows in order to keep the Fire to a vigorous Heat; which was done for two Hours Continuance before the Fir-board was burnt through, when, there was only a weak lambent Flame at the under Part of the Board; but it could not flame out for want of proper Fuel, becauſe the Subſtance of the Board was reduced to a brittle Charcoal
by

300 PROGRESS of FIRE S

by the Heat of the Inch depth of Earth which lay on it, and which hindred the burning Board from flaming: And it was observable that the Edges of the Board burnt only with a live Coal like a Match, being hindred from flaming by the Earth which lay upon the Board.

659. MAY it not hence be reasonably inferred, that when a House is on fire it may be a probable Means considerably to retard the Progress of the Fire, to cover with Earth the Floors of several of the adjoining and more distant Houses, which stand in the Course of the Progress of the Flames. The thicker the Earth is laid so much the better; but if Time will not permit to lay it more than an Inch thick, then supposing twenty-seven Men to carry each a cubick Foot of Earth, which will be a cubick Yard; that cubick Yard of Earth will cover thirty-six square Yards of Floor an Inch thick, which repeated several Times, would soon cover all the Floors of a House: And as the Fire probably mounts with great Rapidity and Fierceness up the Stair-cases, it will be well to lay much Earth on the Stairs, which will give some Check, especially as the Earth on the
Stairs

Stairs and Floors may be wetted by the Fire-engines.

660. AND as Fires often catch from House to House at their upper Parts, an upper Floor covered with Earth, with the Rafters burning on it, will not only flame less, but will also be the longer in burning to such a degree as to fall on the next Floor; and when fallen there, it will also be the longer in burning, on account of the Earth on that Floor; and the Flames also will be the less, and consequently will not be so apt to fire the next House. This Method must doubtless be better than to blow up Houses in order to stop the Progress of Fire.

661. EARTH may most commodiously be had, and that free from the usual Crowd on such Occasions, either in the back Yards or Cellars, and other Ground-rooms; and Pick-axes, Spades and Shovels, with a proper Number of small Sacks, may lay ready for Use with the Fire-engines. If the Sacks are big enough to contain two Bushels, then a Bushel of Earth may conveniently be carried in each of them like a Wallet over the Shoulder, with half the Earth at each End.

302 PROGRESS of FIRES

662. THIS Method might be very serviceable where there is no Water, or but little, only sufficient to wet the Earth.

663. THESE Hints from one who never saw a House on fire, will, 'tis hoped, be farther improved by those who have more Experience and Skill in these Affairs.

664. I AM informed that it is a common Practice in *Scotland*, in case of Houses on fire, to lay Dung and Muck on the Floors, and to throw Water on it; which, where it can readily be had, must be of good Service.

665. AND by a Letter dated *July 17, 1756*, from his Excellency Mr. *Porter*, our Ambassador at *Constantinople*, to the Rev. Mr. *Wetstein*, Chaplain to her Royal Highness the Princess of *Wales*, the Reasonableness of this Practice is confirmed; in which he says, *viz.* that though he communicated the Proposal to them, (which I sent him two or three Years since) yet they did not comprehend the Reasonableness of it: but that in the great Fire which happened there the fourth of that Month, and destroyed 22,372 Houses, their Zeal to save the *Patriarchal Church* and the
Greek

Greek Church, excited some of them, when it was thought all human Means were vain, to throw Dirt on the nearly flat Roofs of the Houses (which were low) of an intervening Street; others improved on it by first wetting the Earth, and then plastering it on the Roofs of the Houses; and thereby stopped the Progress of the Flames, which with the Fire in the preceding *September*, burnt down two-thirds of the City.

666. CONSIDERING the frequent great Devastations by Fire in many large Towns and Cities, it has long been a matter of Wonder to me, that it has not many Ages since put Mankind upon so obvious and effectual a Remedy to this great Evil, *viz.* the obliging People to build thick Partition Walls of Brick or Stone between all new-built Houses, as has been wisely practised in *London* for more than forty Years past, to the very great Benefit of the Inhabitants.

667. AND would it not be a prudent Precaution in Cities and large Towns already built, especially where the Houses are only of Timber, to have Partition Walls of Brick or Stone between every tenth or twentieth House,

304 FORCE of HURRICANES

House, or in what other Proportion shall be thought proper. This to be done at the common Expence of the Owners of the Houses in every Street.

A Proposal to try if the Force of Hurricanes can in any degeee be abated : As also to abate the Noxiousness of some Kinds of sultry sulphureous Airs in hot Climates.

668. **B**EING INFORMED, that for a Day or two, more or less, before the dreadful Hurricanes which arise at *Jamaica* and the *Leeward Islands*, there is a very hot sultry Air, to such a degree as to wither the green Leaves ; also that the Sea is agitated with great Surges : and having shewn by several Experiments in my Analysis of the Air, that such sultry Heat in the Air is probably owing to the great Ferment which arises between ascending sulphureous Vapours and the very cold dense descending purer Air, whose expansive Elasticity is thereby destroyed, and that in great Quantity ; and also instantly,
when

when the Ferment increafes to the Degree of explosive Lightening, which in the time of Hurricanes is great and inceffant, with only a little Thunder at firft, (for in proportion to the Degree of *Vacuum* in the Air, Sound will be abated;) this attended with very black Clouds, which are occafioned as well as the Violence of the Hurricane, by a great Quantity of elastic Air's being deprived of its expansive Force; whereby a confiderable Degree of *Vacuum* being made in the Air, which before fustain'd its watry Vapours in a more rare difperfed State, they are now condensed into black Clouds: The circumambient Air alfo rushing into the Vacuity with great Velocity and Violence from all Quarters, thereby makes thofe tempeftuous, rebuffing, whirling Hurricanes, which bear down all before them with Devaftation and Destruction.

669. THESE Circumftances confidered, whatever the Event may be on Trial, I hope it will not appear ridiculous, but a Thing worthy of Confideration; whether, in a matter of fo great Importance, fome Means might not be found out to inkindle the fulphureous Vapours fome Hours before they would kin-

306 FORCE *of* HURRICANES

dle if left to themselves ; and thereby probably to abate the Force of the Hurricane by letting it off thus prematurely before there was too great a Quantity of sulphureous Vapours collected together, or before the sulphureous Ferment was arrived to such a degree as to have its greatest Quantity of Matter ready for Explosion.

670. Attempts of this kind might be made with Bombs, or Granadoes, shot to great Heights out of Cannon, or by Rockets. Some Rockets have been observed to mount 1200 Yards up in the Air, which, as well as Bombs, carry a Train of Fire to great Heights up into the Air, and then burst with Wild-fire in them ; which might also be put into the Bombs and Granadoes, to try if the sulphureous Vapours in the Air might not thereby be inkindled ; as it is well known that the Flame of a Candle will kindle the like Vapours in Mines, and make them go off with a vast Explosion : Or Paper-kites may be raised to a very great Height, by fixing the Line of the first Kite to the Body of the second Kite, and so on to the third, fourth, or fifth, &c. Kite ; the lower Kites to be larger and larger than the preceding
upper

upper ones: And a Rocket might be fired by means of a Match at the upper Kite when at its greatest Height. Pistol-barrels might also by the same means be fired off at great Heights.

671. ANOTHER Way of attempting the Thing might be by *Phosphorus*, or by the violent Effervescences which are caused by several Mixtures, particularly such as Copperas-stones, &c. or Filings of Iron, or Pyrites, with *Aqua-fortis*, or other acid Spirits; the Fumes of which I have shewn make a violent Ferment and Effervescence with Air, and destroy much of its Elasticity. This effervescent Mixture might be put into a small deep Pot fixed to the Pole of a Rocket, or to the Kites; as might also *Phosphorus*. These sulphureous Vapours being thus carried to great Heights in the Air, might more probably take effect there than near to the Earth, on account of the greater Ferment it is probably in there with the purer Air: And if once inkindled, the fiery Effervescence of the Air would soon expand with great Velocity as far as the Air was prepared to receive it, on account of the great Quantities of sulphureous

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308 FORCE of HURRICANES

phureous Vapours it was there impregnated with.

672. IT is probable, that a considerable Quantity of these sulphureous Vapours are not so high in the Air as to be above the Reach of Cannon-shot; for those who have been on high Hills, have observed Lightening to inkindle among the Clouds below them. And as these sulphureous Vapours, which cause Lightening, ascend from the Earth, so it is thence probable, as also from the sultry Ferment which is then felt in the Air, that they are in great Plenty in the lower Regions of the Air, but do not usually inkindle into Lightening till they come to intermix with the purer Air above the Clouds, as is probable from the Event of several Experiments in the *Analysis of the Air*.

673. AND whereas, as it is above observed, that the Sea is for some Days before a Hurricane, agitated with great Surges; this I think may probably be accounted for by the Fermentation of separate Volumes of sulphureous Vapours here and there with the purer Air, whereby the Air in those separate Parts being destroyed, will cause the Sea-

water to rise and swell into Waves, which are again instantly repelled downwards by the Force of the Air, which must needs descend with Rapidity to fill up the void Space. And this is a probable Reason why the Sea is agitated in some great Earthquakes, as at *Port-Royal* at *Jamaica*, viz. by the like Explosions of large Volumes of sulphureous Vapours on mixture with the pure Air, as I have shewn in my Treatise on Earthquakes.

674. I AM credibly informed, that the sulphureous Vapours in Sir *James Lowther's* Coal-mines near *Whitehaven* being apt to kindle into an Explosion by the Flame of a Candle, they have found means to procure a Light for the Miners to work by, viz. by the incessant striking Fire with Flints on the Steel Edges of swiftly revolving Wheels. Whence we see, that sulphureous Vapours are more apt to be inkindled by some kinds of Fire than by others; which shews the Reasonableness of trying in this Method all imaginable Varieties of Fires and effervescent Mixtures.

675. THE Vapours arising from the Effervescence of a Mixture of Oil of Vitriol and

310 FORCE *of* HURRICANES

Filings of Iron, will be inkindled into a Flame by the Approach of an electrified Body ; and Air is electrical also by the Flame of a Candle.

676. In *Pensylvania* Mr. *Franklin* having fixed a Vessel of Spirit of Wine and Iron-wire to the Tail of a Kite, the Spirit of Wine was fired in a sulphureous and consequently highly electrical State of the Air. Hence it seems probable that the inkindling such a sulphureous State of the Air, may by some such Means be hastened.

677. It would be adviseable to repeat hourly Trials of this kind, *viz.* till the Effervescence of the Air was arrived to such a degree as to qualify it to be inkindled by these Means, if on trial they shall be found to have any Degree of such Efficacy.

678. As to Whirlwinds, such Attempts to check them would be to no purpose, because they are not occasioned by sulphureous inflammable Vapours, but by Eddies in the Air.

679. If very sulphureous Air can thus be inkindled, it might be of great Service in other Cases

Cases where the long Continuance of such State of the Air is very prejudicial to the Inhabitants, so as to make them in several hot Climates, to wish for Lightening; which, as I am credibly informed, is sometimes the case in *Charles-Town* in *South-Carolina*, where the long Continuance of a reddish dusky sulphureous State of the Air makes it very unwholesome, but becomes healthy again when the Air is purified by Lightening.

680. THE Reason why Thunder-clouds are observed to go contrary to the Wind, seems to be this, *viz.* In that sulphureous State of the Air much Air being destroyed, the watry Vapours are thereby condensed into darker, thicker Clouds, called Thunder-clouds; and the Degree of *Vacuum* causes an opposite Wind to rush in, which being destroyed by the sulphureous Vapours and the Lightening, more and more black thick Clouds are formed in a Direction contrary to the Wind, till at length they are condensed to such a degree as to fall down in what are commonly called great Thunder-showers.

312 On ICE-HOUSES,

Some Experiments and Observations on the Princess of Wales's Ice-house at Kew : And on the Degrees of Coldness of a Mixture of pounded Ice and Salt, and of Iced Cream.

681. **T**HE WELL of the Ice-house is about fifteen Feet deep, and the Height of its Dome the same ; the Thickness of its Crown, Brick and Earth, $6 + \frac{1}{2}$ Feet.

682. *June 17, at 12.* The Warmth in the Shade near the Ice-house, 42 Degrees above the freezing Point, by *Farenheit's* Mercurial Thermometer.

683. **W**HEN the Ball of the Thermometer was half an Inch distant from the Ice in the Ice-house, the Mercury stood 4 Deg. above Freezing, or into Thawing ; and yet the Ice did not thaw, *viz.* for want of the Acid in the close confined Air : for when acid Salt is mixed with pounded Ice it immediately melts, and that notwithstanding its Coldness at the same Time greatly increases.

and ICED CREAM. 313

684. WHEN the Ball of the Thermometer touched the Ice, the Mercury stood at the freezing Point.

685. AUG. 5, at 11 Morn. The Wind Northerly, the Warmth in the Shade near the Ice-house, was 67.

686. IN the House near the Crown of the Arch 54, a little above the Straw which lay on the Ice 54.

687. IT is of great Importance to have this Straw which lies on the Ice very dry; when therefore it grows damp, it ought to be changed.

688. WHEN the Ball of the Thermometer was put into a Mixture of pounded Ice and Salt, the Mercury was 34 Deg. below the freezing Point, whereas 8 Deg. below Freezing will freeze the *Thames* over, if it continue so cold for some Days; pounded Ice and *Aqua-fortis* is very much colder than a Mixture of Ice and Salt.

689. IT was very observable that as the Mixture of acid Salt and Ice melted, the
Cold

314 *On* ICE-HOUSES,

Cold increased to 34 Deg. below the freezing Point, but in seven Minutes it began to grow less cold.

690. Now 34 Deg. below the freezing Point, is 98 Deg. colder than human Blood, which is 64. Bosom-heat 62.

691. HAVING placed the Thermometer in Cream without Sugar, when frozen to Ice it was 6 Deg. below Freezing.

692. AUGUST 7, at Noon. When the Warmth in the Shade was 72, Cream with Sugar froze 4 Deg. into Freezing, and when taken out of the freezing Mixture, in seven Minutes the Thermometer rose two Degrees, in seven Minutes more a Degree more, in seven Minutes more half a Degree above Freezing, in 30 Minutes 10 Degrees above Freezing. The Diameter of the Cream in which the Thermometer stood, was full four Inches.

693. COULD Iced Cream be made as cold as a Mixture of Ice and Salt, if eaten then, it would probably instantly kill; for the intense Coldness of such a Mixture has been
known

and ICED CREAM. 315

known to maim the Hands and mortify the Fingers of those who have unwarily handled it for some Time.

694. AND as Iced Cream is commonly not eaten till about half an Hour after it is taken out of the freezing Mixture, it is probably usually eaten when it is some Degrees into Thawing, and probably more so in warm Climates; and as Iced Cream is about 64 Degrees colder than our Blood, it ought doubtless to be eaten sparingly and with Caution: And the like Precaution should be used in the drinking of Liquors cooled with Ice, especially when Persons are warmed with Exercise or Labour, many labouring People having been killed by drinking when very hot, cold Beer or Water, which has probably been no cooler than 16 or 20 Degrees above the freezing Point; for common Well-water, and the Warmth of the Earth at that Depth, is about 14 or 16 Degrees; which is the Reason why it is necessary to have a considerable Thickness of Straw between the Ice and the Walls of the Ice-house.

695. THE Heat of *Holt Water* in *Leicestershire* is 85 Degrees, the *King's Bath* at
Bath

316 On ICE-HOUSES, &c.

Bath 82, *Buxton* in *Darbyshire* 54, *Bristol* hot Well 47, *St. Winifred's* at *Holywell* 32. Captain *Ellis* found the Degree of Cold in *Hudson's-Bay* 88 Degrees below the freezing Point, and *Monf. Delisle* found it several Degrees colder in *Siberia*, viz. 125.

696. JULY 11, I found the Warmth of the Blood of a Turtle which was killed in the Princess of *Wales's* Kitchen at *Kew*, to be 32 Degrees, viz. half as warm as human Blood, and double the Warmth of common Spring or Well-water; the Warmth of the Water in which it was before it was killed, was 36, the Warmth of the Air in the Shade 68: The Lungs of the Turtle are large, and dilate much, the Air-vesicles are as large as those of other Animals which can live a considerable time under-water without breathing, viz. Frogs, Toads, Evets, &c.

*An Account of an Experiment shewing
the ill Consequence of drinking Tea,
or other Liquors very hot.*

697. **I** PUT the thickest End of a small sucking Pig's Tail into a Cup of Green-tea, when the Heat of it was 114 Degrees above the freezing Point by *Farenheit's* Mercurial Thermometer, that is, fifty Degrees hotter than human Blood, which is sixty-four Degrees, a Degree of Heat, at which the warmest Tea is often drank. This Degree of Heat soon scalded the Skin so much, that in less than a Minute the Hair slipped easily off.

698. AFTER cutting the scalded Part of the Tail off, which was about an Inch long, I put the same unscalded End of the Tail into the same Tea when its Heat was 94 Degrees or 30 Deg. hotter than the Blood, *viz.* above half the Heat of boiling Water, which is 180 Degrees, a Degree of Heat, than which few drink it cooler. This also scalded the Skin in a Minute, so as to cause the Hair to come off easily.

699. THERE is therefore from these Experiments, Reason to suspect that the frequent daily drinking of such hot Liquor is hurtful, agreeably to the general Opinion of Physicians.

An

An Account of some farther Improvements made in the Methods of distilling great Quantities of Sea-water without Ventilation, since the Publication of my Book on that Subject.

700. **I** FOUND the Heat of the Wreak of boiling Water in the upper Part of a closed Boiler, to be equal to the Heat of boiling Water, viz. 212 Degrees by Farenheit's Mercurial Thermometer, the Ball of which was held in that Wreak two Inches above the Surface of the boiling Water; but when the Ball of the Thermometer was within two Inches of boiling Water in an open Still without its Head on, and four Inches below the Mouth of the Still, then the Mercury rose but to 180 Degrees, viz. thirty-two Degrees short of the Heat of boiling Water, the cooler incumbent Air continually descending among the lighter hot ascending Vapours.

701. **AND** finding the Heat of the Air blown through a Worm-pipe twelve Feet long and half Inch diameter, the Worm-pipe Tub being full of scalding-hot Water, to be 162, the Heat of the scalding Water in the
Tub

Tub being 188 Degrees, a like Worm-pipe was fixed in the Head of Mr. *Durand's* Still, a Pewterer in St. *Martin's-lane*, in order to try whether the blowing such hot Air in Showers up through the boiling Water in the Still, would proportionably increase the Quantity of the Liquor distilled; but the additional Increase was on trial found to be very inconsiderable.

702. I FOUND the Heat of the Wreak of boiling hot Water in a Boiler without a Cover on it, at two Inches above the Water, to be 161 Degrees, *viz.* fifty-one Degrees below boiling Heat; and the Quantity evaporated in boiling an Hour, was $5 + \frac{1}{2}$ Pounds, the Diameter of the uncovered Pot at the Surface of the Water being $9 + \frac{1}{2}$ Inches, whereas $6 + \frac{1}{2}$ Pounds were evaporated in an Hour's Boiling in the same Pot when covered with a Lid, which was raised so as to be open full one-fourth Inch for a Space for the ascending Wreak to go through. The Heat of the Wreak under this Pot-lid was 212 Degrees, *viz.* equal to the Heat of boiling Water. And Dr. *Langrish*, on making the like Trials, found that twelve Pints, $5 + \frac{1}{2}$ Ounces evaporated in an Hour's Boiling from
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an uncovered Still, whose Wreak was $8 + \frac{1}{2}$ Inches diameter; but with the Swan-neck Still-head on, fourteen Pints nine Ounces were distilled in an Hour. The Heat of the Wreak of my uncovered brewing Copper, when the Water boiled violently, was but 170 Degrees at two Inches above the Water; the Diameter of the Copper at the Surface of the Water, was thirty-one Inches.

703. HENCE it is reasonable to believe, that when large Evaporations are required, the Quantity evaporated may be considerably increased by having a Cover to the Boiler punched full of Holes, or oblong narrow Slits like a Nutmeg-grater, with the rough Side uppermost; by which means if any of the condensed Vapour should settle on the Out-side of the in some small degree arched Cover, it would trickle down in the Spaces between the Holes or narrow Slits, to the Channel at the lower Edge, and thence be conveyed away through a Pipe. The Size and Number of these Holes or Slits must be found out by Experience; the Scum of them must not be so great as to cool the Vapour under the Lid below, or very little below the Heat of boiling Water.

704. WHEN another Porridge-pot twelve Inches diameter, full of boiling Water, was covered with an inverted Culinder full of Holes, and five Inches deep, the Mercury in the Thermometer was heated by the Wreak only to 180 Degrees, *viz.* thirty-two Degrees short of the Heat of boiling Water: whence it appears that there were too many Holes in the Culinder, so as to admit Air enough to cool the ascending Vapour as much as it was cooled in the abovementioned open Still without its being covered with its Head. There was a small Degree of Damp on the Outside of the Culinder, but not enough to cause it to trickle down.

705. WHILE I was intent on these Things, it occurred to my Thought to add to my Still-head, which had a Swan-neck on its Top, a Chanel within-side near its lower Part, to receive the condensed Vapour which settles on and trickles down the Inside of the Head; the Pipe through which the Liquor runs from this Chanel uniting with the Swan-neck, a little before it enters into the Worm-pipe of the Worm-tub; both these Joinings to be cemented close with a Paste, made with a Mixture of equal Quantities of Meal and
Y Chalk,

Chalk, with a little Salt. By this means near double the usual Quantity of Liquor was distilled, and that without blowing Showers of Air up through the distilling Liquor.

706. BUT in distilling Mint or Peppermint, no more was distilled than with the Swan-neck only: Hence it is probable that no more Vapour arose through the Mass of Herbs than what could be carried off by the Swan-neck only; and consequently the Channel below within the Head, was of no service towards the increasing the Quantity of the distilled Mint or Peppermint-water, though it contributed considerably to increase the Quantity distilled from pure Water; from which a greater Plenty of Wreak arises.

707. IT next occurred to my Thoughts to attempt a farther Improvement in Distilling, by a Means which I had thought on many Years since, and which could most commodiously be put in Practice in the Head of Mr. *Durand's* Still in *St. Martin's-lane*, which was well formed for the Purpose, it having cylindrical, circular, upright Sides five Inches and three quarters deep, and twelve Inches and one quarter diameter, with an arched
Cover.

in DISTILLATION. 323

Cover. In the Head of this Still six flat Pewter-plates were set edgeways about an Inch distant from each other, with small Channels at their lower Edge on both Sides, to receive what Liquor condenses on and trickles down from their Surfaces into these small Channels, which convey it at each End into the larger circular Channel. These Partitions were soldered at each End, and at the Top, to Lifts of Pewter, thereby to fix and unite them as in one Frame, in a right Position, and at proper Distances from each other ; they were at both Ends half an Inch short of the Sides of the Head, thereby to give room for the Vapours the more freely to ascend, and come at the Inside of the Head.

708. THE happy Event of several Trials was, that whereas a Pint of Water was five Minutes in distilling in Mr. *Durand's* Still, when it had only the common lower Channel within ; yet when the Swan-neck was added on the Top, and six Pewter Partitions within the Head, then a Pint of Water was distilled in several different Trials in one Minute and forty Seconds, in the Presence of some of the Commissioners of the *Viſtualling-office* ; and not long before that, in eleven Trials a Pint

was distilled in a Minute and twenty Seconds, with the Variation only of two or three Seconds in each Trial. Sometimes there were distilled in the same Still at the Rate of four Gallons in an Hour, in which Time only twelve Pints were distilled in the common way; and sometimes the Quantity distilled, was in the Proportion of five to two. These little Variations were principally owing to the unavoidable different Degrees of Fire; notwithstanding which, we see the Benefit from these thus improved Stills is very great. If therefore we make an Estimate of the great Quantities distilled, from the Event of the Trials which were made before the Commissioners of the *Viçtualling-office*, of a Pint being distilled in several Trials in a Minute and forty Seconds, which is but one-third of the Time, *viz.* five Minutes, in which a Pint was distilling in the common way, that is, at the Rate of twelve Pints in an Hour in the common way, and three times as much, *viz.* thirty-six Pints, or four Gallons and two Quarts, by the improved Method; which will amount to fifty Gallons in twelve Hours with this small Still, which is but fifteen Inches diameter within at its widest Part, and contains six Gallons: and in larger Stills proportionably

portionably greater Quantities will be distilled. This, supposing there is no Delay in refilling the Still, and bringing the cold Water to a boiling Heat, which Inconvenience is remedied by Mr. *Wyche's* happy Contrivance, *viz.* by causing the hot Water at the upper Part of the Worm-pipe-tub to run into the Still through a Pipe with a Turn-cock, as fast as the Liquor distills off.

709. POWDERED Chalk, to prevent the rising of the Spirit of bittern Salt, must from Time to Time be put in at a Hole in the upper Part of the Still below the Head, in the Proportion of half an Ounce to a Gallon of Water: This Hole to be immediately closed, to prevent any Abatement of the Quantity distilled.

710. If this new distilled Water should have a vapid Taste, it will soon be made more palatable by blowing Showers of fresh Air up through it, with a proper Tin Air-box full of very small Holes.

711. BLOWING Showers of Air up thro' the distilling Liquor, does not in any degree cause the Increase of the Quantity distilled,

though in a common Still it about doubled that Quantity ; which remarkable Event Mr. *Durand* and I observed in both our Stills, *viz.* probably because the ascending Vapour is so fully saturated with Moisture, that it can contain no more. A happy Event, that such great Quantities of Water can thus be distilled without the Trouble of blowing Air up thro' it, in the manner which I have described in the Book on that Subject: in which Book I have also given an Account how readily to sweeten stinking Cask-water, by blowing Showers of fresh Air up through from an Air-box full of small Holes: by which means also I have there shewn that musty Liquors, and the ill Taste of Milk from some kinds of Food of Cows may be cured ; and also Cream and Milk-fillabubs easily and readily made by the same Means, and Fishes be preserved alive, &c.

712. THE Sum of the inner Surface of the Head of Mr. *Durands* Still, is equal to 324 square Inches ; and the Sum of the Surfaces of both Sides of the fix Pewter Partitions, which are fix and half Inches broad or deep, is 288 square Inches, nearly equal to the inner Surface of the Head of the Still. Hence

we

we see the Reason of the happy Event, that proportionably greater Quantities are distilled in equal Times by thus increasing the inner Surface of a Still-head for the ascending Vapours to condense on, and thereby making Room for the more Vapour instantly to arise from the boiling Liquor, whose Surface was about one-fourth of the inner Surface of the improved Still-head.

713. MR. *Durand* made such a Still-head for the *Britannia*, an *East-India* Ship, of the following Dimensions, *viz.* the Diameter of the cylindrical Pewter Head *a n*, *Fig. 26. Plate V.* $17 \frac{1}{2}$ Inches, its Depth seven Inches; the Depth of the arched Cover *d*, seven Inches; the Swan-neck at *z* six Inches wide, its small End *x* is united to the straight Neck *b y*, by the short Pipe *x g*, which is soldered at *x* to the Swan-neck, but enters a Hole at *g*, so as commodiously to be put on and taken off with the Swan-neck and arched Cover *r*; the Neck is $11 \frac{1}{2}$ Inches diameter, and five Inches deep; the lower Part *c*, on which the Neck is fixed, and which covers the Boiler, is two Inches deep. The straight Neck *b y*, is fixed on one of the Ship-boilers, pointing towards the Ship's Side; and in order to pre-

vent the Inconvenience of the heeling of the Ship, a Pipe *i k* is soldered to the Still-head at *i*, and to the straight Neck at *k*; by which means the condensed Liquor has a free Passage from the Still-head, whither the Ship heeled to the Starboard and Larboard Side.

714. IN *Fig. 27. Plate V.* is described the Form and Position of the seven Pewter Midribs, which are connected and united in a Frame by the Straps of Pewter *c c c c* near their upper Part, and by the metalline Circle *a a* below, to which they are soldered: *d d d d* are the small Channels into which the condensed Liquor trickles down from both Sides of the Partitions, and thence runs into the large circular Channel; the middle largest of them is ten Inches deep and $15 \frac{1}{4}$ wide, the least eight Inches deep, eleven wide. The Sum of the inner Surface of this Still-head, and both Sides of all its Midribs, is equal to 1539 square Inches. The Diameter of the Ship's Boiler, which contains thirty Gallons, is twenty Inches broad and twenty-six long; the Surface of the Water equal to 520 square Inches. Mr. *Durand*, from a Still with a like Still-head, about an Inch in diameter less than that of the Still in the *Britannia*, distilled

led a Quart in two Minutes and half in six different Trials, with the Variation only of one or two Seconds.

715. IF in some Cafes it shall be requisite to have a Still-head to both the Boilers, their Noses may be joined before they enter the Worm-pipe of the Worm-tub; and if there shall be great Inconvenience in some Ships in distilling from the Ship-boiler, it may be done in a Still fixed above Deck before the Foremast, as was done in King *Charles* the Second's Time.

716. DR. *Langridge* of *Winchester*, wrote me word, that he made a new Still-head to his Still, whose four Sides were each two Feet square; within which Head he fixed sixteen Tin Partitions at equal Distances from each other, with small Channels on both Sides at their lower Edges, in the same manner as was done in Mr. *Durand*'s Still: the Partitions were each twenty-one Inches broad and high; it had no Swan-neck at the Top. This Head thus prepared, he very properly calls a *Condensing Chamber*, which being fixed on a Still which was 19 Inches diameter, and contained
thirty-

thirty-two Gallons. There were distilled in several Trials forty-six Pints of Water in an Hour, with inconsiderable Variations of more or less; whereas with the old spherical Head, which was twelve Inches diameter, with a Swan-neck on it, only $14 + \frac{1}{2}$ Pints were distilled in an Hour; so that full three to one more were distilled by this Means than in the common way, the inner Surface of the improved Still-head with sixteen Partitions, being thirty-six times larger than that of the old spherical Head, and about fifty times more than the Surface of the boiling Water in the Still: by which means the expanded ascending Vapour condensing on so large a Surface as fast as it ascended, gave room for the Vapour to ascend the more freely, and in the greater Plenty from the boiling Water. Farther Experience will determine the proper Proportion of the inner Surfaces of Still-heads to the Surface of the boiling Water in the Still, so as neither to be too needlessly large, nor so small as to lessen in any degree the Quantity that may be distilled; but it will be adviseable to have it rather something too big than in any small degree too little. Probably a Still-head with a something less inner Surface than Dr. *Langrish's* had, might suffice;

fice; which might easily be known by making Trials with fewer Partitions. The square Form of Dr. *Langrish's* Still-head seems more commodious and proper to fix Partitions in than the round, because it allows Space for their being all of the same Length.

717. WHILE Mr. *Durand* and I were making these Trials, it occurred to Mr. *Durand* to make the following farther Improvement on Mr. *Wyche's* abovementioned Proposal, *viz.* to have a moveable round Head to rest on the upper smooth, even Edge of a Hoop, fixed within the Worm-tub about a Foot more or less as shall be found proper, below the Surface of the Water; and when the Water in the Worm-tub is hot enough, then to fix the moveable Head down on the Hoop, by means of two Sticks whose lower Ends are fixed on Hinges, and their upper Ends thrust through small Pieces of Wood fixed to the Worm-tub, thereby to prevent the rising and floating of the moveable Head; the important Use of which is not only to prevent the Descent of the powdered Chalk into the lower Water, but also there to stir it well with a Whisk, thereby to incorporate the Chalk with the Water, and to
continue

continue whisking it, till it, with the Chalk, all run into the Still through an Inch Bore-pipe, where the tumultuary Agitation of the boiling Water will prevent the subsiding of the finer Chalk.

718. IN order to find out what degree of Refrigeration this would occasion in the Still, I made the following Trials in my Wathing-copper-boiler, which was twenty-three Inches diameter at the Surface of the Water, and contained twenty-two Gallons : In ten Minutes after the Fire was kindled it was heated from 45 to 80, viz. 35 Degrees, and in four Minutes more to 94, viz. 14 Deg. in the two next five Minutes each 38 Deg. more, and in the next five Minutes 40 Deg. viz. to 212 the boiling Heat, in 29 Minutes ; then I took five Gallons out in two Pails, which when cooled to 115 Deg. was poured back into the Boiler, which reduced the boiling Water to 17 Deg. below the boiling Heat, and in $5 + \frac{1}{2}$ Minutes it acquired a boiling Heat : The same being repeated, and the Water in the Pails poured into the Boiler when its Heat was 160 Degrees, the Water regained a boiling Heat in two Minutes. Whence we see that the Delay is not long

in refilling the Still in this useful manner, and bringing the Water to a boiling distilling Heat; which will also be considerably sooner, and perhaps without any Intermission or Delay, when the hot Water runs more gradually into the Still through a Pipe of an Inch Bore. It is adviseable not to fill the Still very full, nor to make the Water boil very violently, because of the rising Ebullition, which is the greater on account of the Chalk.

719. THERE are five Ounces and half of Salt in a Gallon of Sea-water, and a Gallon of Water can dissolve nine times that Quantity, *viz.* $49 + \frac{1}{2}$ Ounces. Hence in the Case of Mr. *Durand's* lesser Still which holds six Gallons, an Estimate may be made of how many additional Gallons may be added before the last three Gallons are saturated, with as much Salt as they can dissolve, *viz.* with $148 + \frac{1}{2}$ Ounces of Salt, which being divided by $5 + \frac{1}{2}$ Ounces in a Gallon of Sea-water, the Product is twenty-seven Gallons; from which six Gallons which were at first put into the Still, are to be deducted, so that twenty-one additional Gallons may from time to time be put in, to bring the remaining three Gallons of Water in the Still to that degree of
Satu-

Saturation, when twenty-four Gallons will be distilled ; though perhaps a Quantity less than this, may be the proper Quantity : But the more may be distilled on account of the great Quantity of Chalk, *viz.* thirty Half-ounces which were put in the Water ; but, as Mr. *Durand* rightly observed, that about one-third more was in equal Times distilled from fresh Water than from Sea-water with Chalk in it, by reason the Water does with the more Difficulty extricate itself from the fixed Substances of Chalk and Salt : so if it shall be found by Experience that the Sea-water distills off slower and slower in proportion as the Water in the Still grows by these repeated Effusions saltier and saltier, and fuller of Chalk, then this too briny Water must so much the oftener be all taken out of the Still, in order to refill it with more Sea-water.

720. AND in a Thirty-gallon Still, about 120 Gallons of Sea-water may from time to time be added, before the remaining fifteen Gallons in the Still will be fully saturated, with as much Salt as they can dissolve : After which several Refillings of the respective Stills will probably be requisite to empty out the
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too briny Liquor, and then refill the Stills with more Sea-water. Experience will best shew how often the Refillings are to be repeated. It may accurately be known whether any Spirit of bittern Salt arises, by dropping two or three Drops of Solution of Silver in *Aqua-fortis*, in a little Glafs of the Water: for if there is a very small Quantity of Spirit of Salt, it will seize on the *Aqua-fortis*, and cause it to let go the Silver, which will then fall in white Clouds. The Goodness of the distilled Water may also be known, by its boiling common yellow Pease soft. Mr. *Durand* distilled five Gallons of good Water from six Gallons of Sea-water, in which there were three Ounces of powdered Chalk.

721. BUT some are apprehensive that this great Improvement in Distilling, may be of ill Consequence in making those destructive Spirits cheaper which are already but too cheap: Had not the Improvement been of great Benefit to Mankind in many other Respects, I should have been far, very far, from endeavouring after it, or discovering it. But should the Event be to make those Spirits cheaper, and consequently by spreading farther, more destructive: the Consequence of
that

that will be, that the increased raging Devastation will the sooner necessarily rouse the Nations to put a stop to what must be done hereafter: But as yet few of the Nations, whose very Vitals are thereby consuming and destroying, endeavour to put any Stop to it; except the Heads of the native *Indians* in *North-America*, who have long repeatedly intreated the *English* to sell them no Rum: which is as effectually extirpating of them as the Hornet did the unsubdued Remainder of the *Canaanites*.

722. IF Mankind, instead of receiving and entertaining this Pest with almost universal Applause and Approbation, could prevail with themselves to be in earnest to deliver themselves from it, then much might be done towards it, either by withholding it, or by lowering and weakening all kind of fermented distilled Spirits with Water to a salutary Degree; as is now practised in our Plantations in *America*, in making Punch so weak as not to be hurtful; which, when it was much stronger, was well known to destroy Multitudes. And where the like humane, wise, and laudable Practice has been used in Ships, it has had the same happy salutary Effect.

723. WHAT Necessity, or even Temptation can there be, to be averse to the making them wholesome instead of being venomous and destructive; and that not only of the Lives, but even of the Morals of Mankind? How much therefore does it behove all who have any Concern for the Honour and Dignity of their own kindred Species, any Indignation at its being thus debased and disgraced, any Bowels of Pity for the vast Multitudes, not less than a Million, that are yearly destroyed all over the World by this moral as well as natural, and therefore worst of all Evils that ever befel unhappy Man, to use their utmost Endeavours to deliver Mankind from this Pest? Was there ever a more important Occasion to rouse the Indignation of Mankind? Can we be calm and undisturbed, when this mighty Destroyer rears up its invenom'd Head everywhere? The most zealous Advocates for Drums, even the unhappy besotted Dramists themselves, the prolonging of whose Lives, and whose real Welfare both here and hereafter is hereby sincerely intended, cannot find fault with this well meant Remonstrance in defence of them, and of all Mankind against this mighty Destroyer, from one who has long been labour-

Z ing,

ing, and that not without Success, in finding Means to preserve Multitudes of Lives by various Ways.

724. IT is the just Observation of a judicious Writer, *viz.* “ That this slow Poison
 “ first destroys the Strength of the Body,
 “ and then makes Villainy a sort of Condi-
 “ tion for preserving in Misery those Lives it
 “ has before made wretched; it is an avowed
 “ Enemy to Industry and Honesty, and strikes
 “ at the Roots of Wealth and Power by ener-
 “ vating the Common People, who are Riches
 “ in Peace and Strength in War.”



To the Rev. Dr. *HALES*.

O ! qui capacem nobilis artifex eludis orcum, &c.

SOUGHT out by *Study* and confirm'd by *Art*,
The Glorious *SECRET You* at length impart ;
The *Gift of Heaven* be henceforth its Name,
Well it deserves that venerable Claim :
O ! could the *Muse* the wond'rous Thought pursue,
Worlds should be told of something *Great and New*,
And pay their just Acknowledgment to *YOU*.
How will our honest *TARS* rejoice and smile,
How boast the Genius of their native Isle !
Methinks I hear them in the burning Zone,
Blessing that *Life* which thus preserves their *own*.
No more in parching Heats to mourn and waste,
And eye that Water which they dare not taste ;
But boldly take——by thy propitious Thought,
With Extacy the safe luxurious Draught,
Shall quaff each Night the new-invented Bowl,
To worthy HALES good health——with all my Soul ;
Shall prove to *Indian Seas* what *Thou* hast done,
And tell thy *LABOURS* to the *Eastern Snn*.

This is thy Praise, Name thy Reward, who can ?
Who knows the Price of *General Good* to Man ?

By Dr. *Richards*, M. D. of *Grantham, Lin-*
colnshire.

Di-

Directions for sweetening great Quantities of stinking Cask-water in Ships.

725. MENTION BEING made Page 55 in my little Book, *On distilling Plenty of Sea-water, and sweetening stinking Water, &c.* that the main gross Stink of three Gallons of stinking Water was blown off in five Minutes, by ascending Showers of fresh Air blown through a Tin Air-box full of Holes, such as is described in that Book; and a Bowl full of stinking Water being thus sweetened in two Minutes, which is now much practised with great Approbation in many Ships. And Mr. *Littlewood*, a Shipwright at *Chatham*, having sweetened, as he told me, a Butt of stinking Water in an Hour, it is reasonable to believe that great Quantities of Water sufficient for the most numerous Crews, may easily and effectually be sweetened by the following manner, which would be of great Benefit to their Health; for besides the nauseous Disagreeableness of it, putrid Water will have a strong Tendency to produce putrid dangerous Distempers, *viz.*

STINKING WATER. 341

726. To have a Pewter Pipe, *Plate III. Fig. 25.* *b. c. n.* about $\frac{3}{4}$ Inch diameter within, with a like Cross-pipe *d. n.* sixteen Inches long, with two other like Pipes closed at *x* and *z*, made exactly to fit and slide on the Ends *d* and *n* of the Cross-pipe, with a Slit and small Knob at *d* and *n* to fix them fast, as Bayonets are fixed at the Ends of Muskets. These long Pipes *x. z.* to have shorter lateral Pipes *o. o. o. o.* on both Sides four Inches long, and with small Holes in four long Rows, *viz.* one above, one below, and on each Side, and the short lateral Pipes the same; the Holes to be about $\frac{1}{20}$ Inch diameter, at $\frac{1}{3}$ Inch distant from each other; but towards the Ends *x* and *z* to be nearer to each other, that the Water may thereby be the more readily drove out of the Tube, to make room for the Air to reach the very Ends *x* and *z*, in which there should be a few of the like Holes; the upright Pipe *c. n.* to have no Holes in it, and to be so long as to reach down to the Pipe *x. z.* at the Bottom of the Butt laid lengthways on Deck. When the Ship heels much, it will be well to move the Pipe *x. z.* so as to rest on the then lowest Part of the Butt, that the Showers of Air may

Z 3 the

the better ascend through the middle of the Water. With the like Pewter Air-pipe eighteen Gallons of stinking *Thames* Water were sweetened in a Kilderkin, by blowing Showers of fresh Air up through it, in fifteen Minutes, in the Presence of his Excellency Seignior *Mello de Castro*, Envoy from the King of *Portugal*, and of Dr. *De Castro Sarmento*, F.R.S. Whence we see how easy it is to sweeten a sufficient Quantity of stinking Water for whole Ships Crews.

727. THE double Bellows, with two or three strong spiral Springs within to contract down the upper Board, to be of the full Size of large Kitchen Bellows, or rather double that Size if needful. My Bellows are $11 + \frac{1}{2}$ Inches broad in the broadest Part, and $15 + \frac{1}{2}$ Inches long from the Iron at the narrow Nose End of the Board to the Beginning of the Handle. These Bellows are to rest on a Block fastened towards the End of the Butt, and on a lesser Block near the small End of the Bellows, to both which they are to be bound fast with Cords; or they may be fixed by any other Means that shall be found more proper. The short Nose of the Bellows to be
an

an Inch diameter within, to be united by the leathern Pipe *a. b.* to the Pewter Pipe *b. c.* the Boards of the Bellows to be thick and strong, and the Leather to be strong and supple, and very wide, to give room for high and deep Strokes; the Bellows to be lifted up very quick, that the Water may have the less time to run into and fill the Pewter Pipe, and if the spiral Springs do not contract with Force enough, then a proper Weight must be fixed on the upper Board near the Handle of the Bellows.

728. I HAVE found that with two Feet Depth of Water, the Showers of Air may be blown up through it; though it requires so considerable a Force to do it, that eighteen or sixteen Inches Depth will do better and sooner. It will be requisite to stir the Water in the Cask frequently with a Broom, in order to forward the Sweetening, by thus bringing the more distant Water within the Reach of the ascending Showers of Air: And when one Quantity of Water is thus sweetened, it may be pumped into sweet Casks for Store-water, to make room to sweeten more. If the Spread of the Length and Breadth of a Butt shall be found too large for such Bel-

lows, a Hogthead may be made use of instead of a Butt; or, if it were practicable to divide a Butt by a Partition fixed a-cross in the middle, it might be better for the Purpose.

729. GREATER Depths and Breadths of Water might be ventilated with Smiths Bellows, but they cannot well be fixed on Deck without being too cumbersome; and this Operation ought not to be done between Decks, unless in well ventilated Ships, or with open Ports; because the mixing the foul putrid Vapours in the Ships with the Water, may endanger the making it unwholesome.

730. It is probable that the same double Bellows properly placed at the Well of a Ship, may prevent the much stinking of the Bilge-water, as described in Page 60 in the abovementioned Book, *viz.* by means of a Pewter or Copper Pipe full of small Holes, laid round the Main-mast at the Bottom of the Water in the Well, and blowing Air up through it now and then at its first beginning to stink, when a little Blowing may probably suffice; but when it stinks much, it must be pumped out in the usual Way, because

STINKING WATER. 345

because Blowing then would raise too great a Plenty of unwholsome putrid Vapours.

731. THE Well of the Parsonage-house at *Farringdon* near *Alton, Hampshire*, which is seventy-two Feet deep to the Water in Chalk, being observed to extinguish a Candle let down into it, especially when the Springs are low, the Rev. Mr. *Lissett*, at my Desire, let down a Candle twice about the middle of *November*, when the Springs were not much risen, when the Candle was both times extinguished by the noxious Vapours when it was about half way down; he then poured six Watering-pots full of Water in Showers thro' the Rose of the Pot; on letting down a Candle, both an Hour and two Hours after in the Evening it was not extinguished, nor its Light in any degree diminished; the next Morning the Candle was not extinguished till it came down near to the Surface of the Water; he then poured in a Shower, only one Pot-full of Water; after which the Candle descended to the Water, and ascended without any Diminution of its Light. Hence it evidently appears how effectual this easy Method will be to cure for some Hours the noxious Vapour in Wells, either at their first

3 Digging,

Digging, or when cleansed : By the same means the deadly Vapour of some Bog-houses may be purified for a short time, as also the noxious putrid Vapour in the Well of a Ship : or if there is a like bad Vapour in any other Part of a Ship, or in a Drift, or other Part of a Mine, it may be purified by squirting horizontally Showers of Water thro' a Rose from a Fire-engine. Thus also Cities have sometimes been freed from the Plague by Showers of Rain, which purifies the Air by washing down the pestilential Vapour.

THE END.



A G E N E R A L I N D E X O F T H E

MATTERS contained in this BOOK.

- | | |
|--|--|
| <p>A</p> <p>AIR foul, very noxious 86, 152.
 Its different Degrees of Foulness estimated by Candles 125
 Its Acid preserves from Decay 185
 The most putrid and volatile uppermost 190</p> <p>B</p> <p><i>Back-beaver</i> improved 247
 <i>Barracks</i> to refresh 74
 <i>Bellows</i> Hessian, their insufficiency 12
 <i>Breathing</i>, how incommoded 152, 154.</p> <p>C</p> <p><i>Chambers</i> to refresh 64
 <i>Chimneys</i> smoaking to cure 151
 <i>Cloth</i> woolen, to dry by Ventilation 281
 <i>Corn</i> to preserve in Granaries 120, 241
 By <i>Monf. Duhamel</i> 236
 To preserve in Ships 228
 To preserve in Sacks 244
 To clean 247
 To clean by Ventilators 256
 Smutty to clean 258, 260
 Smutty its Noxiousness 259
 Bad ought not to be sown 265</p> | <p>Instances of its great Increase 267
 Dried by hot ventilated Air 272
 <i>Cucumber Frames</i> to refresh 145</p> <p>D</p> <p><i>Drams</i> pernicious 192, 335
 <i>Distillation</i> improved 318
 <i>Dung</i>, its Heat 141</p> <p>F</p> <p><i>Ferries</i>, their Timbers to preserve 192
 <i>Fire-pipes</i>, their Insufficiency 112
 <i>Fires</i>, to check their Progress 299
 <i>Flesh</i> of a whole Animal to salt 283
 To preserve in hot Climates 285
 Frozen to prevent its spoiling 282</p> <p>G</p> <p><i>Gaol Distemper</i> very infectious 28, 44, 158, 161
 To refresh 64
 <i>Distemper</i>, to prevent and cure in Ships 108
 <i>Granaries</i> to refresh 220, 222, 242
 <i>Greenhouses</i> to refresh 145
 <i>Gunpowder</i> dried by Ventilation 260
 In</p> |
|--|--|

I N D E X.

- In Barrels to prevent its Dampness 276
- H
- Habits*, Men governed by 2
Hops to dry 282
Hospitals to ventilate 13, 14, 156
 How much refrigerated thereby 16, 17
 To purify 152
 Their foul Air bad 158
Hurricanes to abate their Force 304
- I
- On Ice-houses* and Iced Cream 312
- K
- Kilns* for Malt or Hops to air 68
- L
- Lace-makers* why unhealthy 153
Linen wet, to dry by Ventilation 281
- M
- Magazines* to dry 275
Malt-kilns to air 68, 282
Melon Frames to refresh 145
 Their Warmth and Foulness 142
Midriffs improved 8
 Their Axils how fixed 10
Mines to refresh 132, 133, 135
- N
- Nets* for Herrings to preserve 218
- P
- Pigeon-houses* to refresh 219
Pitch, to prevent its boiling over 297
- Q
- Quarentine Ships* soon to pu-
- trify 75, 77, 79
- R
- Rats* to destroy in Ships 235
Rooms crouded to refresh 69
 To refresh 150, 156, 157
- S
- Salt* to make 277
Scurvy, its Causes 87
Sea-water, its Degrees of Coolness and Saltness at different Depths 122
Sea-gage described 122
Ships ventilated 82, &c. 96, 108, 111, 118
 To preserve from decaying 88, 118, 162
 The Impurity of their Air 110
 Preserved by Salt 185
 To preserve without Ventilators 187
 Sheathing to preserve 287
 To preserve from Worms 289, &c.
Spirit of Vitriol salutary in putrid Distempers 75
Spirits distilled, most noxious 193
Stables, their foul Air 130
- T
- Tea* scalding-hot unwholsome 117
Tents to refresh 71
Thunder-clouds, why they move contrary to the Wind 311
Timber to preserve 287, 288, 295, 296
- V
- Valves* improved 10
Vapours sulphureous to kindle in the Air 311
Venti-

I N D E X.

<i>Ventilators</i> farther improved	Rules for ventilating Ships
8, 11	102
In <i>Winchester</i> Hospital 16	Defects in ventilating Ships
What Degrees of Refrige-	103
ration they cause 17	Small improved 243
In <i>St. George's</i> Hospital 18	To clean Corn with 256
Their Benefit 20	W
In <i>Northampton</i> Hosp. 21	<i>Water Bilge</i> , to retard its
In <i>Bristol</i> Hospital 22	Stink 111
In the <i>Small-pox</i> Hosp. 23	<i>Weevels</i> prevented by Venti-
In <i>Winchester</i> Gaol 25	lation 241
Necessary in Gaols with	Attempts to destroy 262
open Courts 27	<i>Wells</i> , their Air to purify 345
In the <i>Savoy</i> 28	<i>Wine</i> frozen to preserve good
In <i>Newgate</i> 31	286
In <i>Port-Cæsar</i> Castle 65	<i>Wind-mill</i> on <i>Newgate</i> de-
In Ships, where fixed, and	scribed 40
good Effect 82, 97, 100	In Ships 176



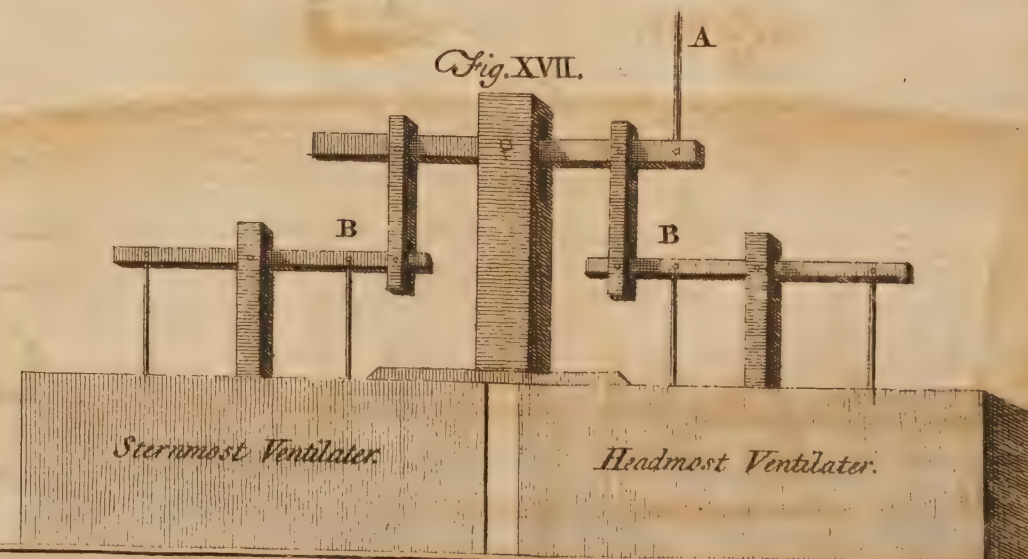
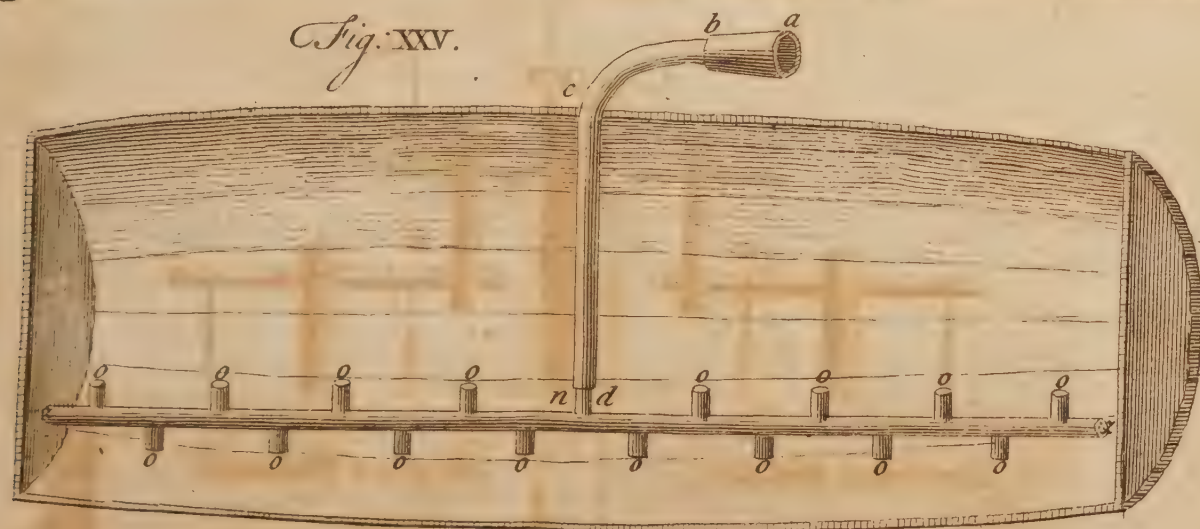
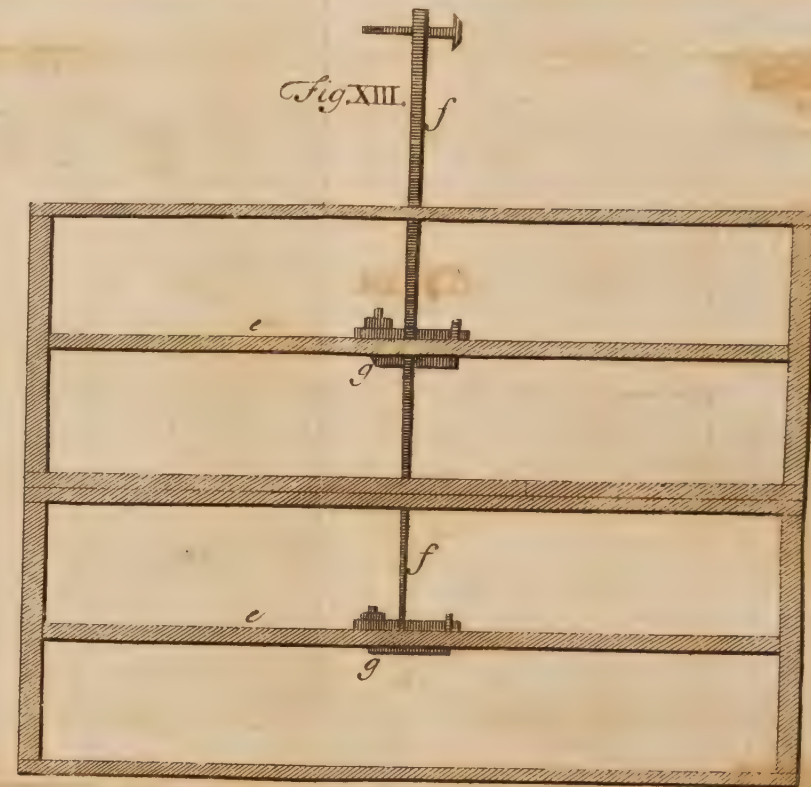
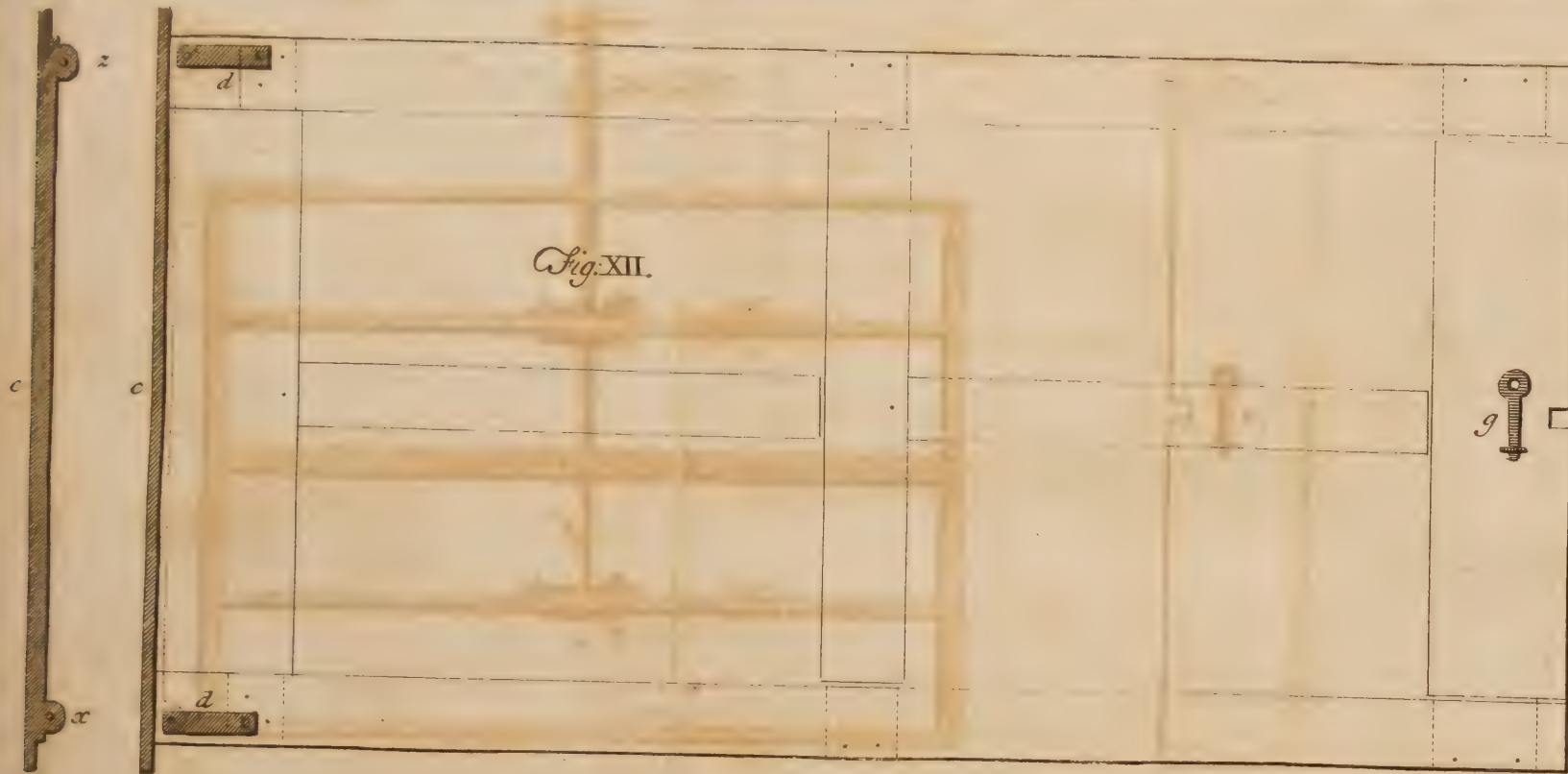




Fig. XIX.

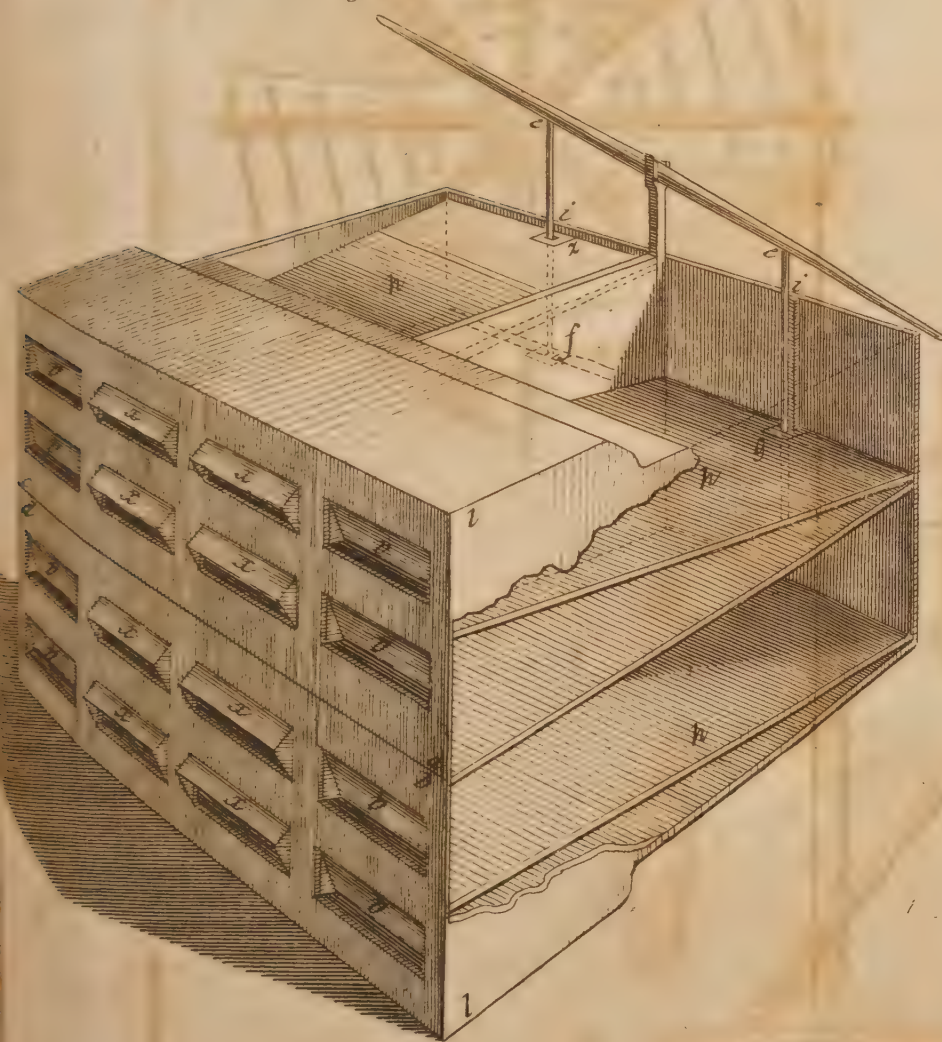


Fig. XX.

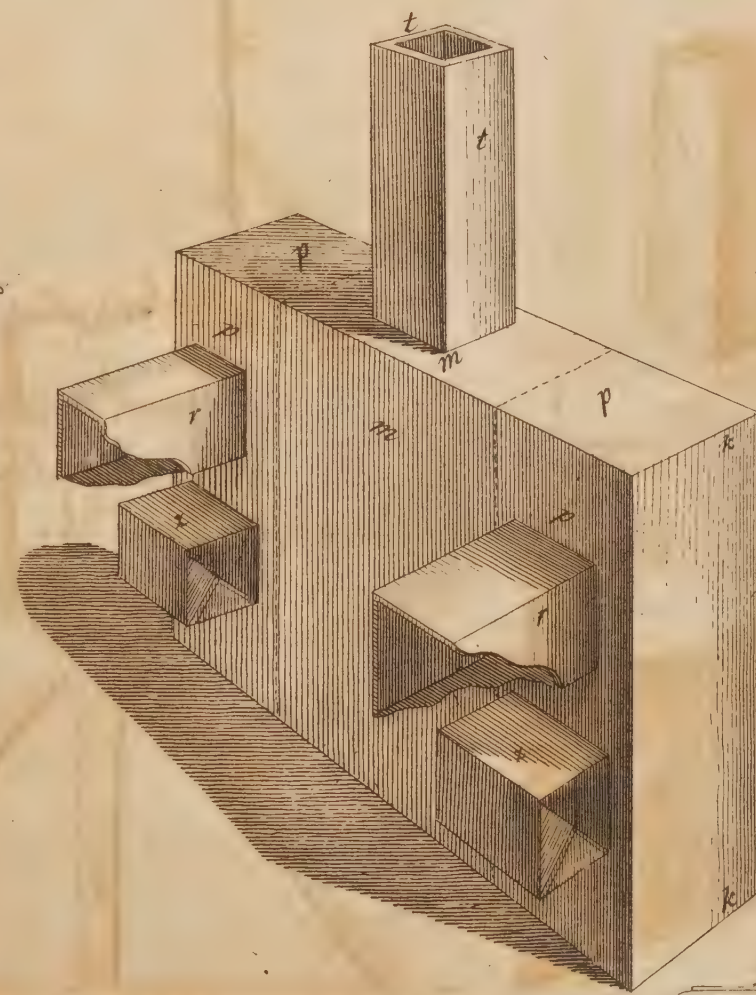


Fig. XXI.

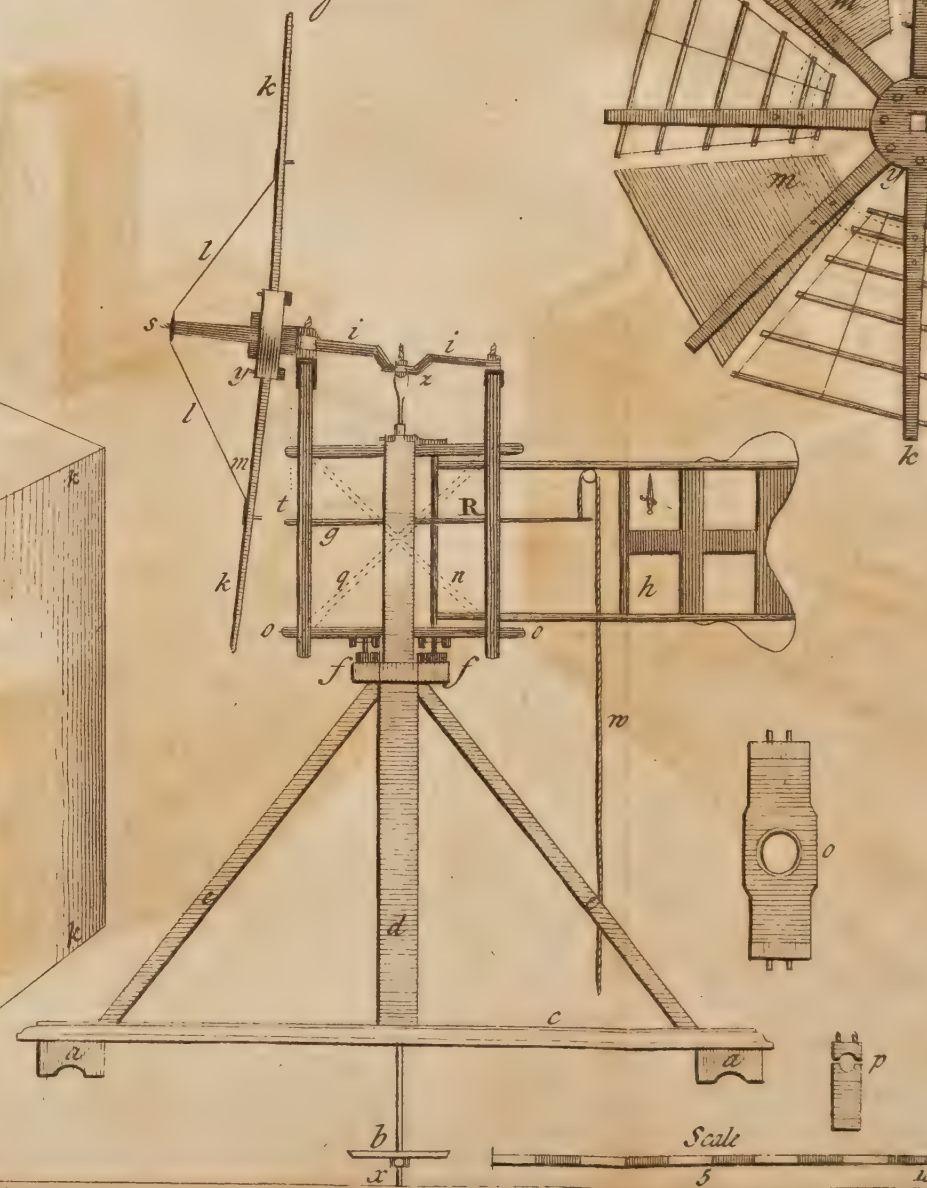


Fig. XXII.

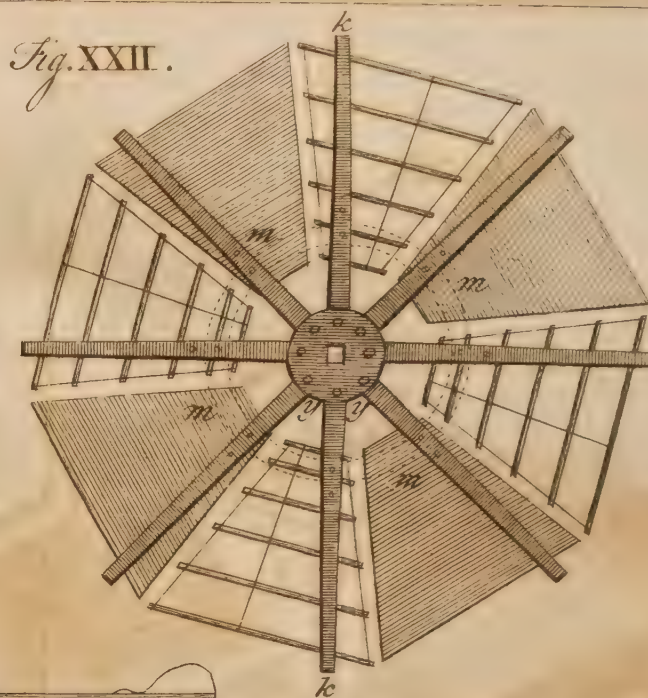




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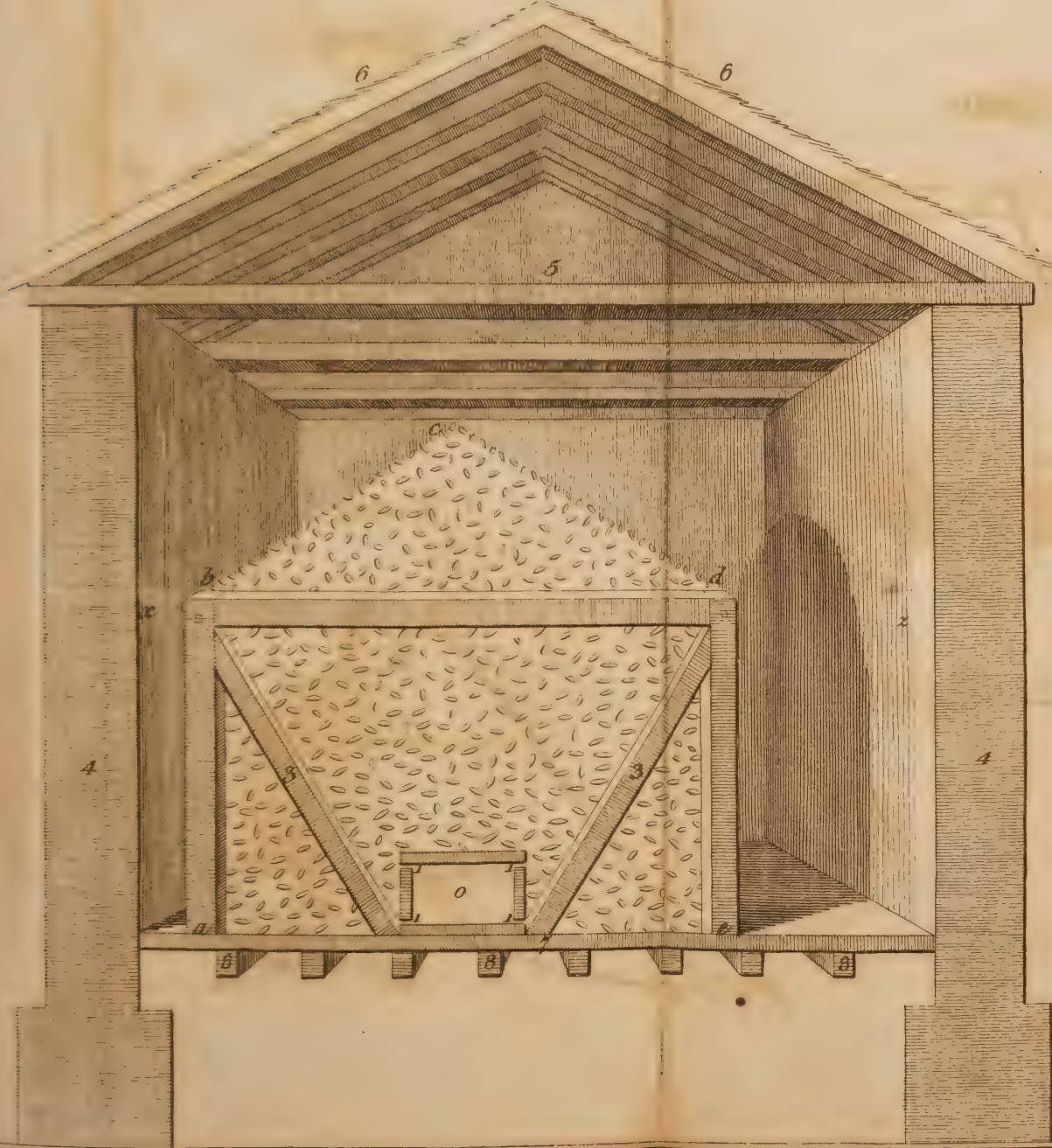


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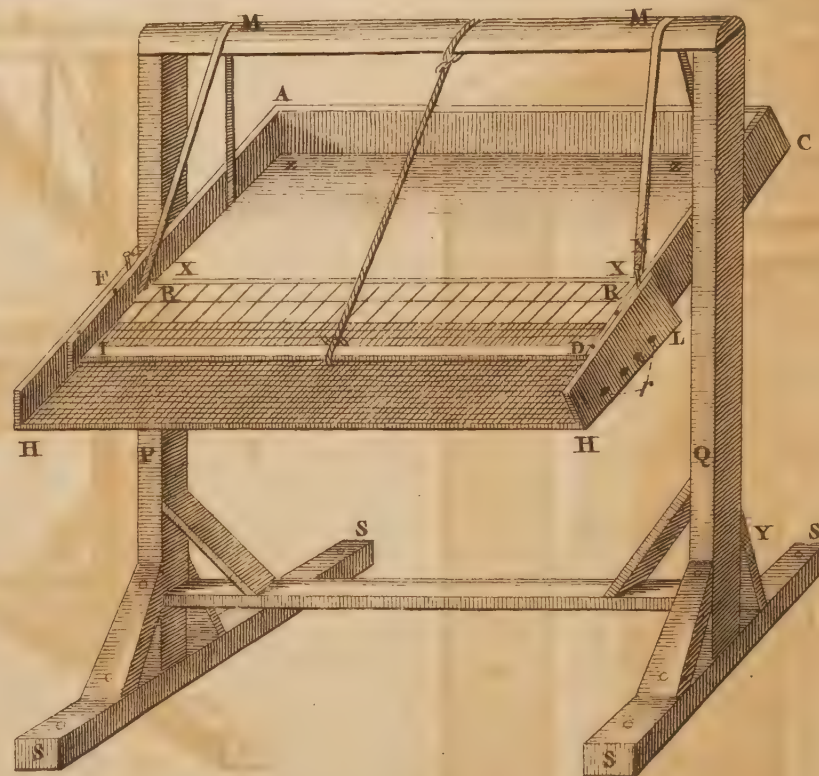


Fig. XXVII.

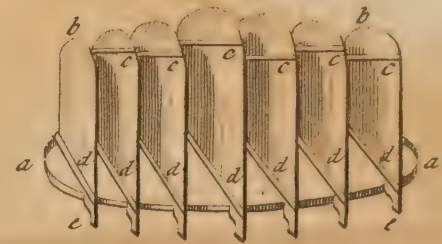
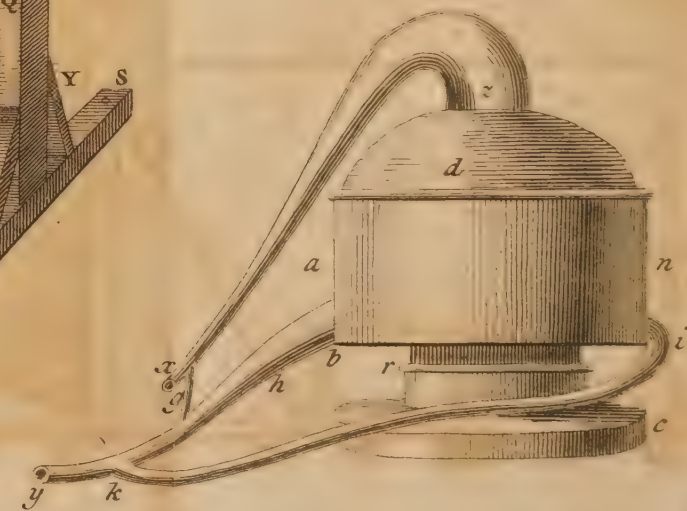
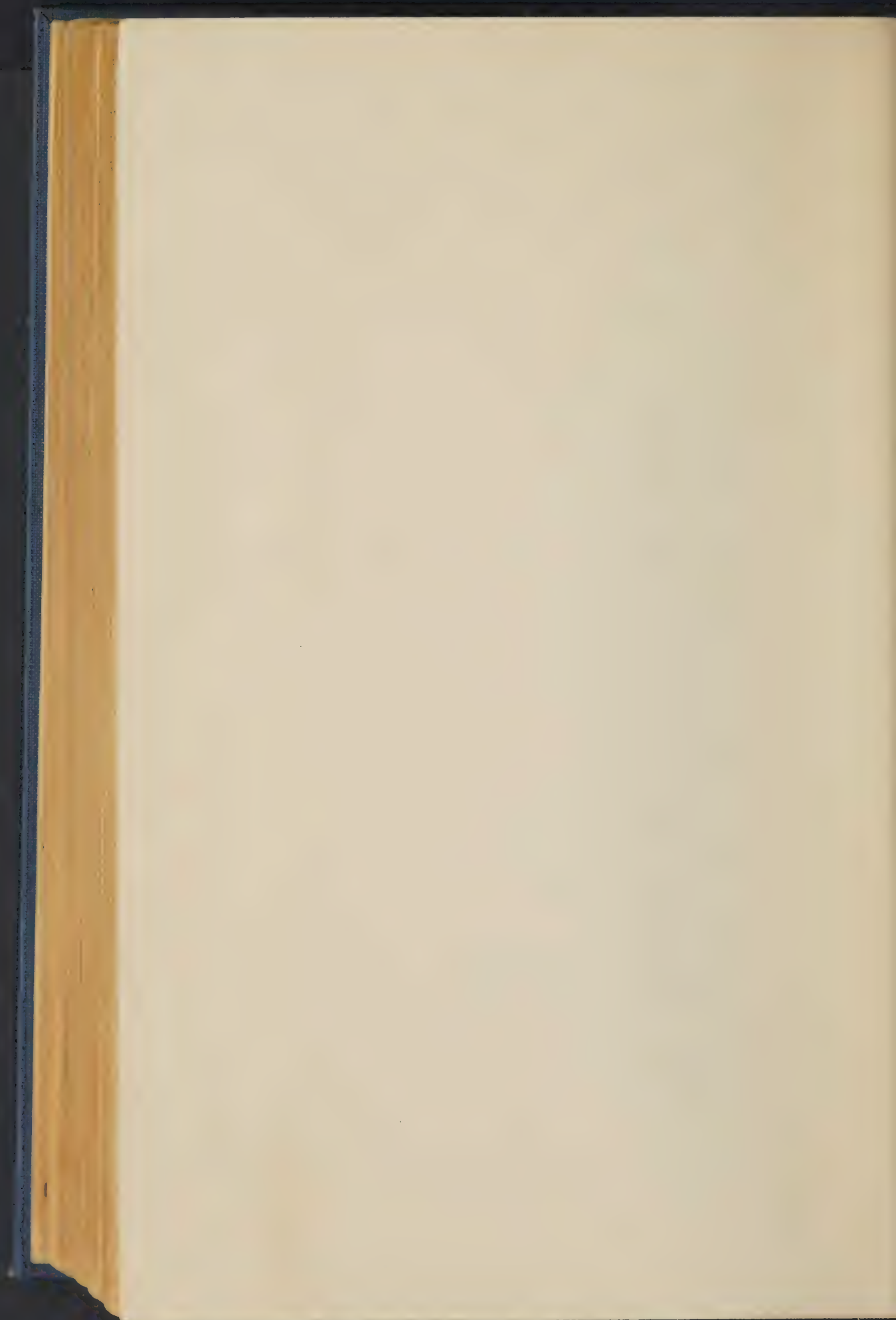


Fig. XXVI.







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